Regd. No. BG. 263

Upper Thirc

DETROIT PUBLIC LIBRARY

MAY 9 1961

GENERAL INFORMATION

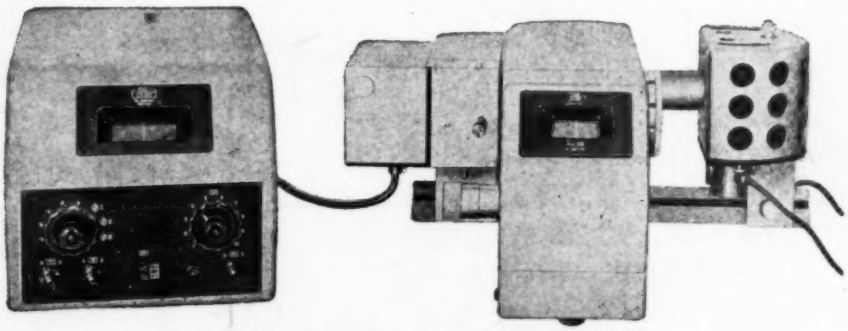
Current Science

Vol. 30, No. 2 FEBRUARY 1961 Pages 43-86

CARL ZEISS

SPECTROPHOTOMETER

Mains-operated Model PMQ II



Made by Carl Zeiss, Oberkochen, Germany

For precise measurements from 200 mμ in the ultraviolet to 1000 mμ in the near infrared region with high spectral resolution. Write for illustrated literature.

Sole Agents

ADAIR, DUTT & CO. (India) Private LTD.

CALCUTTA MADRAS SECUNDERABAD BOMBAY NEW DELHI

IT TAKES TEN YEARS TO MAKE A SCIENTIST

And sometimes as long to find one.
India desperately needs many more.
We ourselves have none to spare.
But we do, in fact, make scientists for others.

Our ADIABATIC BOMB CALORIMETER...

the first and only commercially available set of its kind, reduces by no less than 66% the time and attention spent on other bomb calorimeters in measuring the calorific values of fuels and foods. The trick is to raise the temperature of the calorimeter jacket exactly in step with the rising temperature of the bomb. Not as simple as it sounds, of course. But now achieved, with high precision. **RESULT :** No heat losses, no corrections no tedious slavery to the thermometer; less fatigue, fewer sources of error.

Send for technical specification and prices

Highest grade stainless steel – first class workmanship – unequalled efficiency

AND 66% OF THE SCIENTIST'S TIME SAVED FOR OTHER WORK

A SCIENTIST SAVED IS A SCIENTIST MADE

And the calorimeter sets are available, not in ten years, but now, at a price at which they will pay for themselves in a matter of months.

Gallenkamp

SUPPLY THE WORLD'S LABORATORIES

A. Gallenkamp & Co. Ltd., London, England.

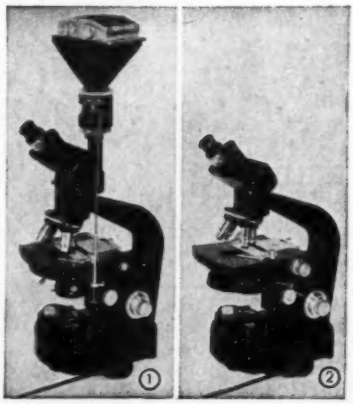
ACCREDITED AGENTS

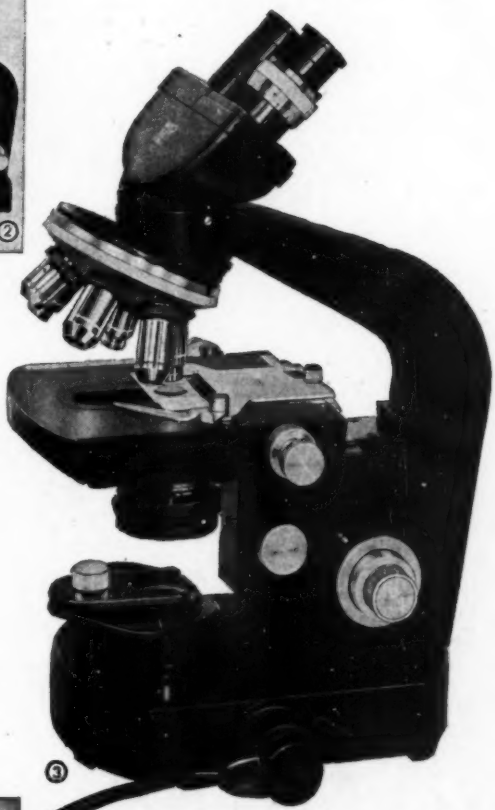
MARTIN & HARRIS (Private) LTD.,

(Scientific Department)

SAVOY CHAMBERS, WALLACE STREET, BOMBAY 1.

WILD
HEERBRUGG





* The most COMPLETE Microscope so far made

* Ideal for QUALITY PRECISION & VARIETY

WILD M 20

The M 20 Microscope with few of its attachments.

Fig. 1 : With Micro Camera and Binocular Tube;
Fig. 2 : Equipped as Phase Contrast Microscope ;
Fig. 3 : With Six-Hole Nosepiece ; Filter Exchanger, etc. ;
Fig. 4 : Built-in Illuminator for Kohler Illumination.

Sole Agents:

RAJ-DER-KAR & CO.

Sadhana Rayon House
Dr. D. Naoroji Road
BOMBAY-1

Telephone : 26-2304 Telegram : TECHLAB

Branch Office:
44/6 REGAL BUILDING
CONNAUGHT PLACE
NEW DELHI-1

Gansons

'GS' GAS PLANTS Electrically operated
'GS' GAS PLANTS WEIGHT DRIVEN
for field laboratories & places without electricity
SUPERIOR LABORATORY EQUIPMENT AND APPLIANCES
Incubators, Ovens, Baths, Shakers, Stills, etc.
Equipments for handling and storing
RADIOACTIVE ISOTOPES
STAINLESS STEEL FABRICATIONS
Pilot Plants, Tanks, Kettles, Pressure Vessels, etc.
for Pharmaceutical, Chemical, Food-processing Industries
ORE-DRESSING PLANTS AND EQUIPMENT
Wilfley Table, Froth Flotation Cells, etc.

GANSONS (PRIVATE) LIMITED
P.O. BOX 5576 BOMBAY 14

Model Tv 10 with metal door

AVAILABLE EX-STOCK

GERMAN 'MEMMERT' OVEN MODEL TV 10

GERMAN ROTOFIX CENTRIFUGES (Various)

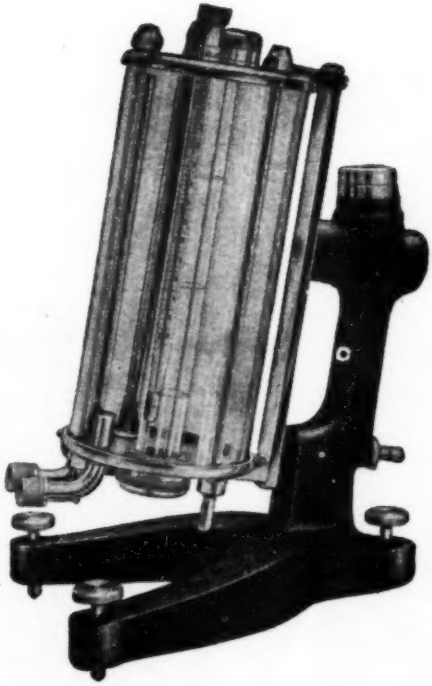
WARING BLENDERS

And other Laboratory Glassware

Please contact for details:

LABORATORY FURNISHERS
DHUN MANSION, VINCENT ROAD, DADAR, BOMBAY 14
Telephone: 62761
Branch: **AHMEDABAD**

HOPPLER
VISCOSIMETER



FALLING BALL
PRECISION TYPE BH

MEASURING RANGE:
0·01-1000000 CP

✠

ACCURACY:
±0·5 per cent.

✠

TEMPERATURE RANGE:
−60° to 150° C.

Manufactured by :

VEB PRUFGERATE WORK

MEDINGEN, DRESDEN
GERMANY

Please write for particulars to :

GORDHANDAS DESAI PRIVATE LTD.

PHEROZESHAH MEHTA ROAD, BOMBAY-1

Branches :

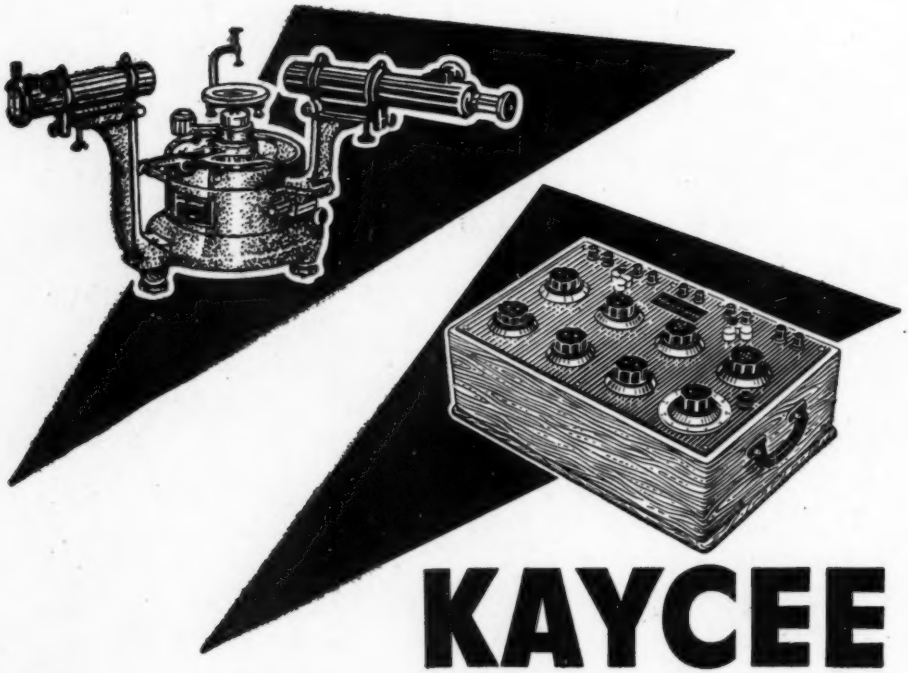
P-7, MISSION ROW EXTENSION
CALCUTTA 1

4/2 B, ASAF ALI ROAD
NEW DELHI

22, LINGHI CHETTY STREET
MADRAS

SP/6D/62

Dependable and accurate



KAYCEE

Scientific Instruments

for Industries and Educational Institutions

BAJAJ ELECTRICALS LTD.

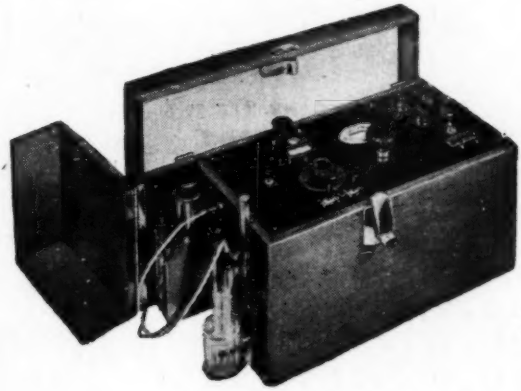
(Formerly RADIO LAMP WORKS LTD.)

BOMBAY • CALCUTTA • NEW DELHI • MADRAS • KANPUR • PATNA • INDORE • WARDHA • GAUHATI

Heros'

LEEDS NORTHRUP

UNIVERSAL pH INDICATOR



This compact, battery-operated instrument, combines laboratory accuracy with the convenience of "on-location" checking. Easily portable, it has a clearly readable scale covering a range of 0 to 13 pH with graduations in 0·1 pH divisions. The indicator measures grounded or ungrounded solutions with a precision of ±0·02 pH. Manual temperature compensation covers a range of 0 to 50° C and an asymmetry potential adjuster permits calibration of the indicator to the pH electrode system.

In addition to pH applications, the indicator is capable of measuring direct potentials, including those originating in circuits of moderately high resistance. For such uses it has a second range of 0 to 1.100 volts, with a scale graduated in 0·01 volt divisions. When the instrument is used for voltage measurements, the temperature compensator and the asymmetry potential adjuster are cut out of the circuit.

This versatile instrument includes pointer galvanometer, polarity reversing switch on voltage range, standard cell, batteries, and battery and range-selector keys. Shielded electrometer tube compartment, high-grade insulation and guarding permit the indicator to operate with full accuracy under high-humidity conditions.

SOLE DISTRIBUTORS FOR LABORATORY EQUIPMENT

THE SCIENTIFIC INSTRUMENT CO., LTD.

ALLAHABAD BOMBAY CALCUTTA MADRAS NEW DELHI

only the best filter papers

You cannot be too careful about the filter papers you use. For consistently accurate results use only GENUINE WHATMAN papers in your laboratory. They are made by modern techniques that guarantee their quality: their properties are examined and controlled at every stage of manufacture. They are preferred by leading scientists throughout the world because with Whatman you can be sure you are getting the correct results in all filtration procedures. They have no substitute. So look at the label carefully and see that it is GENUINE WHATMAN before you buy.

ensure correct *results*

BE SURE

H. REEVE ANGEL & CO. LTD
Gt. Britain: 9 Bridewell Place, London EC4
USA: 9 Bridewell Place, Clifton, New Jersey

Sole distributors of

WHATMAN FILTER PAPERS

Manufacturers W & R Balston Ltd

INJECTABLES — Safe and Dependable

TRADE ITL MARK

A wide range of parenteral preparations for meeting the growing requirements of the Medical Profession are now being processed in our Laboratories. They are made from Standard Chemicals employing double distilled and PYROGEN FREE water. Their containers (Ampoules) undergo rigid neutrality tests before they are selected for use. These Injectables are therefore guaranteed to be absolutely safe and dependable.

The following are but a few of our well-known Injectables:

- RETICULIN .. .. .. A Potent extract of Liver
- HEXOPURIN .. .. .. An urinary Antiseptic
- CALCITOL .. .. .. Injectable Calcium Gluconate
- BEVITAMIN .. .. .. „ Vitamin B_1
- CEVITAMIN .. .. .. „ Vitamin C
- GLUCOSE SOLN. .. .. .. „ Pure Dextrose

The Mysore Industrial & Testing Laboratory Ltd.

Malleswaram P.O., Bangalore 3

Bengal Chemical and Pharmaceutical Works, Ltd.

The Largest Chemical Works in India

Manufacturers of Pharmaceutical Drugs, Indigenous Medicines, Perfumery, Toilet and Medicinal Soaps, Surgical Dressings, Sera and Vaccines, Disinfectants, Tar Products, Road Dressing Materials, etc.

Ether, **Mineral Acids, Ammonia, Alum, Ferro-Alum, Aluminium Sulphate, Sulphate of Magnesium, Ferri Sulph., Caffeine and various other Pharmaceutical and Research Chemicals.**

Surgical sterilizers, Distilled Water Stills, Operation Tables, Instrument Cabinets and other Hospital Accessories.

Chemical Balance, Scientific Apparatus for Laboratories and Schools and Colleges, Gas and Water Cocks for Laboratory use, Gas Plants, Laboratory Furniture and Fittings.

Fire Extinguishers, Printing Inks.

Office: **6, GANESH CHUNDER AVENUE, CALCUTTA-13**

Factories: **CALCUTTA - BOMBAY - KANPUR**

Beckman/Spinco

Ultramicro Analytical System

Significant Advance in Clinical Chemistry

Consists of:

1. **Spectro Colorimeter:** Measures samples faster than standard Colorimeters, has a fixed, self-emptying cuvetts.
2. **Microfuge:** Centrifuges 20 blood samples in 15 seconds—turns off automatically at end of run.
3. **Microtitrator:** Titrates ultramicro samples with precision and ease; can even titrate in a hanging drop.
4. **Micropaks:** Containing the reagents and standards for approximately 1,000 determinations.

In Short:

* Complete analysis on drop size samples.
* Routinely performed by any technician.
* Faster and more precise than present methods.
* No glassware to wash.
* Compact and inexpensive.

EX: M/S. BECKMAN, INC., U.S.A.

Sole Agents:

TOSHNIWAL BROS. PRIVATE LTD.

198, JAMSHEDJI TATA ROAD, BOMBAY 1

BRANCHES:

'RIVAL', KACHERI ROAD, AJMER | 11, BRITISH INDIA ST., CALCUTTA 1 | 14-B/4, N.E.A., UTTARI MARG, NEW DELHI 5 | ROUND TANA, MOUNT ROAD P.O., MADRAS 2

Current Science

Vol. XXX] FEBRUARY 1961 [No. 2

CONTENTS

	PAGE
Infra-Red Spectra of Water—PROF. DR. REINHARD MECKE	43
Rocket to Venus	44
Photosynthesis—T. S. SADASIVAN	45
Symposium on Collagen	49

Letters to the Editor

The Elastic Scattering of 246 Mev Electrons by Lithium-6—N. J. PATEL AND C. M. BHAVSAR .. 51
Crystal Structure Data of Some Rhodites and Ruthenites—D. D. KHANOLKAR .. 52
A Preliminary Study of the Crystal Structure of $La_2Mg_3(NO_3)_{12}.24\ H_2O$—S. N. DUTTA .. 53
The Separation of Uranium from Crude Sodium-Diuranate by Photolysis—D. PATNAIK AND K. SINGH .. 54
Synthesis of 4 : 5-Dihydroxycoumarin : A Rare Observation of Total γ-Substitution in Resorcinol—K. N. TRIVEDI .. 54
A Note on the Fatty Oil Obtained from Nigella damascena *Seeds*—MOHAN L. VISHIN .. 55
A Study of the Rocks at Pandava Falls in Panna State, M.P.—H. B. SAXENA .. 56
Effect of Lucerne Supplement to the Rice Diet on Circulating Hæmoglobin and Plasma Proteins of Rats—B. K. SUR 56
Application of Nickel Chloride to Tea Plants (Camelia sinensis) *and Control of Blister Blight*—C. S. VENKATA RAM 57
Folin-Phenol Reagent for the Measurement of Leaf Proteins—N. G. PERUR .. 58
A Hæmagglutinating Strain of Miyagawanella *Causing Polyarthritis in Sheep in India*—P. G. PANDE, R. R. SHUKLA AND P. C. SEKARIAH .. 59
On the Occurrence of Pelagic Fish Spawn—P. N. GANAPATI AND N. SOLOMON RAJU 61
Germination of Grape (Vitis vinifera *L.*) *Hybrid Seeds by Chilling*—S. N. SINGH 62
An Apetalous Mutation in Tora Brown Sarson (Brassica campestris *var.* Brown sarson) *and Its Inheritance*—DHARAMPAL SINGH .. 62
Formation of Red Rot Acervuli on the Nodes and within the Tissues of Diseased Canes—V. B. SINGH AND KISHAN SINGH 63
Two Fungi Causing Spoilage of Refrigerated Poultry Meat—G. RANGASWAMI AND R. VENKATESAN .. 64
Blight of Fennel in Rajasthan. I. Morphology and Identity of the Pathogen—. N. PRASAD, R. L. MATHUR AND J. P. AGNIHOTRI .. 65
Heylandia latebrosa *DC.—A Promising Legume*—J. V. SHANKAR AND F. R. BHARUCHA .. 67
Morphology, Cytology and Breeding Behaviour of Hybrids between Corchorus olitorius *and* C. capsularis—M. S. SWAMINATHAN, R. D. IYER AND K. SULBHA 67
Epicoccum nigrum *Link. : A New Report from Indian Soils*—R. N. GHOSH .. 69
Multiparasitism by Aholcus euproctiscidis *Mani and* Trichogramma evanescens minutum *Riley in the Eggs of* Euproctis lunata *Walker*—B. R. SUBBA RAO AND M. J. CHACKO .. 69
Pachytene Analysis in Japonica-indica *Rice Hybrids*—S. V. S. SHASTRY AND R. N. MISRA .. 70
Amitosis in the Endosperm of Zephyranthes ajax *Sprenger*—S. L. TANDON AND B. M. KAPOOR .. 72
Chromosome Number of Some Flowering Plants—RASH BEHARI GHOSH .. 73
The Natural Enemies of Marasmia trapezalis (Guen.), *a Pest of Maize and Jowar*—T. V. VENKATRAMAN AND M. J. CHACKO 73
The Chromosome Numbers of a Few More Orchid Genera—A. K. SHARMA AND A. K. CHATTERJI .. 75

Reviews .. 76
Science Notes and News .. 83

Prize Scheme for Lac Research

Indian Lac Cess Committee, Ranchi, Bihar, India, has instituted a Lac Utilization Research Prize Scheme as follows: Two prices respectively of Rs. 10,000 - and 5,000/ are to be awarded once every 3 years for best applied research on Lac. The first award is to be made in 1962. The recipients will also be awarded gold medals worth respectively Rs. 500/- and Rs. 300/-. Research workers from any part of the World will be eligible for the prizes.

For details, please write to:

DIRECTOR
INDIAN LAC RESEARCH INSTITUTE
NAMKUM, RANCHI, BIHAR, INDIA

FOR
ACCURACY
AND
DEPENDABILITY
in
CHEMICAL ANALYSIS & RESEARCH
use
laboratory reagents and guaranteed reagents
Manufactured by

SARABHAI MERCK PVT. LTD.
In conjunction with **E. MERCK A.G.** Darmstadt, Germany
Sarabhai Merck Pvt. Ltd., 13 Wittet Road, Bombay-1.
shilpi-s.m. 381

Just Published

COIR

ITS EXTRACTION, PROPERTIES & USES

A consolidated account of the various aspects of coir technology, notably:

* Extraction of Coir
* Structure & Properties of Fibre
* Spinning, Weaving, Dyeing & Printing
* Production of Ropes, Cordages & Other Coir Products
* Marketing & Trade

Pp. vi+54 **Royal 8vo** **Rs. 6·00**

PUBLICATIONS DIRECTORATE, CSIR
OLD MILL ROAD, NEW DELHI 1

INFRA-RED SPECTRA OF WATER

PROF. DR. REINHARD MECKE

Director, Institut fur Physikalische Chemie, Universitat Freiburg I. Br., Germany

IT is well known that liquid water is practically non-transparent for infra-red radiation. This opacity is due to a strong continuous absorption of liquid water beginning at about 2·5 μ and extending into the far infra-red. The origin and explanation of this continuous absorption have not yet been found. But it has certainly something to do with hydrogen bonding. If, therefore, we can find a solvent for water avoiding hydrogen bonding, it should be possible to get rid of this continuous absorption so that we would observe only the two absorption regions of the normal modes at 3500 cm.$^{-1}$ and at 1610 cm.$^{-1}$ In seeking for such solvents which must have high polarity and ought to be quite transparent in the investigated infra-red region, we have tried, besides others, antimony trichloride which has a melting point at 73·4° C. Although it is not a very convenient solvent to handle it can be used for many purposes in infra-red spectroscopy. It is strongly hygroscopic, so it is not easy to get rid of the water. It is indeed surprising that the absorption spectrum of water in this solvent shows extremely sharp bands at 3500 cm.$^{-1}$ and 1610 cm.$^{-1}$ There is still a continuous absorption left at 700 cm.$^{-1}$ A very similar spectrum with sharp bands and a broad absorption at 700 cm.$^{-1}$ was observed by us recently in a new type of ice crystals which we have called type *b*, besides the ordinary ice crystals of type *a*. We observed this spectrum when water is crystallised at medium low temperature (dry ice) on rock-salt plates. The only difference is that it then splits into three components in the 3 μ-region and also shows the overtone of the bending vibration at 3265/54 cm.$^{-1}$).[1] Figure 1[2] exhibits the spectrum of a mixture of heavy and light water with the three isotopic molecules H_2O, HDO and D_2O. All the bands are extremely sharp. There are some striking peculiarities in this spectrum: The two modes of stretching vibration of the HDO molecule coincide with each of the vibration of H_2O and D_2O, thus making

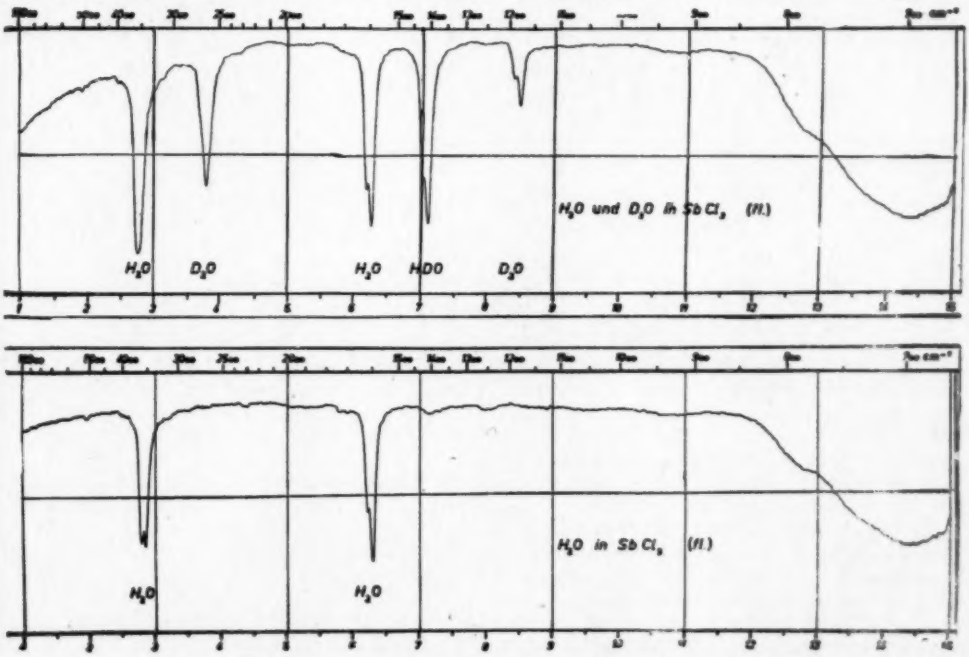


FIG. 1. Absorption spectra of light and heavy water in antimony trichloride.

it evident that there is no great interaction between the vibrations of the HO and DO valence bonds. One fact which cannot be explained is the splitting of the bending vibration. Each of the three molecules shows, as with the ice crystals of type *b*, satellites on the short wavelength of about the same intensity ratio. As the bands are sharp and coincide with the frequencies of the vapour state, there can be no *hydrogen* bonding. But the highly polar antimony trichloride molecule certainly would associate with the water molecule. This association must therefore take place by some sort of *oxygen* bonding to the antimony atom. The splitting may be originated by a coupling effect of the antimony atom. A further point of interest is the same intensity ratio of the satellite to the main absorption band in each isotopic molecule. Without going into further details, I would call attention to the following fact which has not yet been fully realised :

From an infra-red spectrum we get two main kinds of information : (*a*) normal frequency and (*b*) total intensity of a band.

The square of the frequency of a normal vibration is, as is well known, proportional to the force-constant (f) and to the reciprocal mass ($1/m$) :

$$(a) \quad (2\pi\nu)^2 = f \cdot \left(\frac{1}{m}\right).$$

On the other side, the square of the vibrating charge (e) is also proportional to the same force-constant and to the polarisability α of the normal mode :

$$(b) \quad (e)^2 = f \cdot \alpha.$$

The polarisability of a vibration can now be quite easily measured by the total integrated intensity over $d\lambda$ of the band :

$$(c) \quad \alpha = \frac{3}{8\pi^3 N} \int \epsilon_\lambda d\lambda$$

$$(d) \quad (2\pi e)^2 = f \left(\frac{3}{2\pi N}\right) \int \epsilon_\lambda d\lambda.$$

(ϵ—molar extinction coefficient; N—mole-number).

If, therefore, the effective electrical charge of the vibration is *not* dependent on the amplitude of the vibrating mass, the isotopic compounds must have the same intensity in the corresponding bands. As we now have found a solvent which will dissolve water and other simple compounds quite readily in different concentration, we are now able to go into studying this intensity phenomenon of the infra-red spectra of deuterated simple compounds and we shall do so.

1. Mutter, R., Mecke, R. and Luttke, W., *Z. f. phys. Chem.*, Neue Folge, 1959, **19**, 83.
2. The spectra were taken by Dr. E. Klee at my Institute.

ROCKET TO VENUS

WHAT indeed was a significant step forward in space research was the launching of a rocket to the planet Venus by Russia on February 12, 1961. The method of launching itself was unusual and showed the greatest scientific precision involved. The "interplanetary station", as the rocket is called, was launched from a heavy artificial satellite which was put in orbit round the earth earlier in the day, by an improved multistage rocket.

The weight of the automatic interplanetary station is 643·5 kilograms (1420 pounds). Radio transmissions from the Venus rocket are made on the frequency of 922·8 kilocycles on command from the earth. According to the Russian announcement the purpose of the rocket was to carry out a programme of physical observations in outer space. On February 17th the announcement said that the interplanetary station had travelled a distance of about 1,173,000 miles and was going at a speed of 2½ miles per second, and that the equipments, actuated by solar batteries, were functioning normally. The rocket is expected to reach the area of the planet Venus in the second half of May, 1961.

One result of the revolutionary "double system" used in launching the Venus probe is a one-third reduction in the time previously considered necessary for the trip from Earth to Venus. It was calculated by Soviet scientists that with an estimated initial speed of 12 km. per second, the trip to Venus would take 146 days on the most economical orbit. Thus the utilisation of a space platform to launch the actual Venus rocket has permitted an increase of the "breakaway" speed and correspondingly reduced the flight time to Venus.

Venus is nearly of the same size as earth, its diameter being 7,600 miles. Its mean distance from the sun is 67 million miles and its orbit is almost circular ; its period of revolution round the sun is 225 days. Its distance from the earth varies from a maximum of 160 million miles to a minimum of 26 million miles. It comes closer to the earth than any other planet. Venus is currently on one of its closest approaches to the earth, about 35 million miles away.

PHOTOSYNTHESIS*

T. S. SADASIVAN

University Botany Laboratory, Madras-5

THAT isolated chloroplasts are capable of forming carbohydrates from CO_2 and H_2O simultaneously evolving O_2 without any energy other than visible light has given a spectacular lead and paved the way for investigating the fundamental problem of photosynthesis, *i.e.*, the ability to convert light into chemical energy. The theory that photolysis of water is the basic reaction has now been re-examined using isolated chloroplasts and cell-free particles of the photosynthetic bacterium, *Chromatium*, and the results of these experiments are indicative of photosynthetic phosphorylation as a more likely factor in the two systems than photolysis of water as hitherto supposed (photolysis in the botanical sense means "the grouping of chloroplasts in relation to the amount of light falling on plant"; in the chemical sense it means "the decomposition or dissociation of a molecule as a result of the absorption of light"). Isolated chloroplasts have, therefore, provided an effective experimental approach to the separation of the light-dependent phase of photosynthesis in which O_2, TPNH and ATP are formed and the dark phase during which CO_2 is assimilated. The conversion of absorbed light energy into chemical energy, used for CO_2 assimilation in the dark, occurs during the photochemical reactions in which chloroplasts evolve O_2 and form assimilatory power, *i.e.*, ATP and TPNH.

With this background let us now examine the various views put forward in understanding many aspects of this phenomenon of photosynthesis. It is generally recognized that in photosynthesis oxido-reduction takes place by the utilization of hydrogen from water for reduction of CO_2. Therefore, if chlorophyll were involved, as it seems to, in the chain of reactions culminating in the transfer of hydrogen from water to CO_2, the obvious thing to expect is a reversible photochemical oxidation or reduction of chlorophyll resulting in the *storage* of light energy in its photoproducts presumably as reversibly acting unstable quanta. Indeed, this has been shown early as feasible (reversible photochemical oxidation of the pigment in the presence of ferric ions) but whether this is what happens *in vivo* is a moot point. Chloroplast reaction in relation to hydrogen transport is well summarized in Fig. 1. It shows reducing

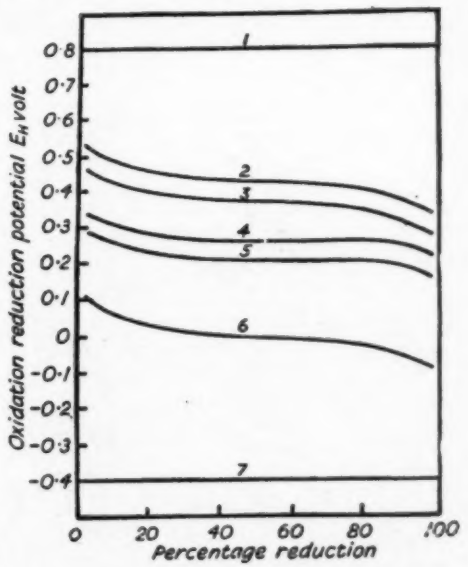


FIG. 1. Potentials and percentage reduction for substances taking part in chloroplast reaction as shown by R. Hill: 1. oxygen; 2. ferricyanide; 3. cytochrome *f*; 4. quinone; 5. 2:6 dichlorindophenol; 6. ferric oxalate; 7. hydrogen (from Hill and Whittingham, 1958).

properties of the chloroplast system, i.e., relationship between the electrode potentials and the percentage reduction of the effective reagents. The reduction of ferric oxalate represents the greatest reducing potential that has yet been obtained in chloroplast reaction. Therefore, chloroplast preparations do not 'split water' to the extent required by the simple formulation of photosynthesis. Two interpretations are possible: (a) either the chloroplast reaction *in vitro* is an artefact and has no direct correlation with processes of reduction occurring in the living cell, or (b) the reduction of CO_2 requires more than the four equivalents of hydrogen chemically necessary. Illuminated

* Summary of address delivered to the Indian Academy of Sciences at the 26th Annual Session at the University of Madras, December, 1960.

The following abbreviations will be used in the text: ADP, ATP, adenosine di- and tri-phosphates; FMN, flavin mono-nucleotide; PGA, phosphoglyceric acid; Ru-D-P, ribulose diphosphate; R-5-P, ribose-5 phosphate; RDP, ribose diphosphate; TPN, triphosphopyridine nucleotide; TPNH, triphosphopyridine nucleotide, reduced form.

chloroplasts catalyse the production of O_2 from H_2O in the presence of certain hydrogen acceptors in a reaction which shows many of the characteristics of the O_2-producing reaction in photosynthesis. However, the reducing properties of illuminated chloroplasts are not of sufficient potential to account for a reduction of CO_2 by reaction with the minimum number of equivalents of H_2. In the present state of our knowledge this conclusion would appear fairly satisfactory although one must admit that positive proof for such oxido-reduction is yet to be found. The intermediates that store light energy subsequent to the photochemical stage are now known to be reduced forms of pyridine nucleotides and high energy phosphates. However, that does not represent the entire list as newer intermediate compounds taking part in this remarkable phenomenon of storage of light energy await discovery and characterization.

Simultaneous action of light of different wavelengths could favour the course of photosynthesis as for example blue-green light of very low intensity was shown to greatly increase the quantum yield of photosynthesis by *Chlorella* in the presence of red light and also due to the action of blue light the long wave limit of *Chlorella* photosynthesis was noted to shift to extreme red region. Nevertheless, joint action of quanta of red and blue light is not indispensable for photosynthesis as, indeed, plant growth in red light alone is known. A further point of interest is that in the region of 450 to 580 mμ O_2 uptake has been noted to increase in plant organs containing no chlorophyll. Light could also affect activity of photoreduced forms of chlorophyll.

Quite recently, Arnon and his collaborators discovered that isolated chloroplasts could synthesize ATP in light. They succeeded in separating the light and dark phases of reaction resulting in the formation of the reduced form of TPN and ATP on illuminating "grana" in the absence of oxygen. The interesting point is that, on illuminating isolated chloroplast, inorganic phosphate gets incorporated into ATP without liberation or uptake of O_2 and this Arnon designated as "cyclic phosphorylation". The rate at which this process proceeded was accelerated if co-factors like FMN, ascorbic acid, vitamin K or similar oxido-reductive systems that could initiate electron transfer were added. Three products of the light reactions in chloroplasts, O_2, ATP and TPNH, are now known to be formed (Fig. 2). Reactions 1 and 2 reveal an unknown capacity of chloroplasts to use light energy for the formation of energy rich pyrophosphate bonds of ATP and is now designated as photosynthetic phosphorylation as distinguished from oxidative phosphorylation by mitochondria. Reaction 1 is now known as "cyclic" and reaction 2 as "non-cyclic" photophosphorylation where only part of the light energy absorbed by chlorophyll is used for the formation of ATP; the remainder is used for formation of a reductant, TPNH, which provides the 'hydrogens' needed for the conversion of CO_2 to sugars. Reaction 3 is a non-physiologic variant of reaction 2 in which TPNH is replaced by ferricyanide.

$$ADP + H_3PO_4 \longrightarrow ATP \qquad (1)$$

reductase

$$2TPN + 2H_2O + 2ADP + 2H_3PO_4 \longrightarrow 2TPNH_2 + O_2 + 2ATP \qquad (2)$$

$$4Fe^{3+} + 2H_2O + 2ADP + 2H_3PO_4 \longrightarrow Fe^{2} + O_2 + 2ATP + 4H^{+} \qquad (3)$$

FIG. 2. Photochemical reactions as postulated by Arnon (1959).

Arnon went further and gave a new orientation to the non-cyclic electron transport process which in photosynthesis of green plants results in a light dependent reduction of TPN, evolution of O_2 and the formation of ATP (Fig. 3). It

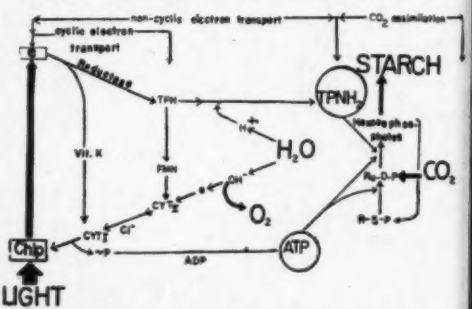


FIG. 3. Scheme for photosynthesis proposed by Arnon (1959).

differs from the cyclic pathway in that an electron expelled does not return to the chlorophyll molecule but is removed from the cyclic pathway by TPN and used either for the reduction of CO_2 and the formation of carbohydrates or under special conditions for the production and accumulation of TPNH. This scheme of Arnon brings out that, chlorophyll, on absorbing a light quantum, becomes 'excited' and expels high-energy level electrons. In both

green plants and photosynthetic bacteria this energy is converted into the pyrophosphate bond-energy of ATP during a 'downhill' return of electrons to chlorophyll through a cyclic electron transport system of the vitamin K type. In the green plants, there is a second cyclic electron transport system of the FMN type for forming ATP and also an open non-cyclic mechanism of electron transport to TPN and this results in evolution of O_2. Cytochrome components are also visualized in electron transport of both cyclic and non-cyclic mechanisms. Photosynthetic bacteria seem to use light energy only for formation of ATP by the vitamin K type of cyclic photophosphorylation. Green plants, however, require both cyclic and non-cyclic electron transport systems for formation of assimilatory power, ATP and TPNH (photosynthetic triphosphopyridine nucleotide reductase, the reducing factor for chloroplasts has now been crystallized; this protein is considered to occupy a prominent place in the reducing properties of light-activated chloroplasts). ATP and TPNH are then used for assimilation of CO_2 to form sugar and starch as dark reactions with regeneration of R-5-P and Ru-D-P. Thus, the formation in light, of reduced phridine nucleotides and high-energy phosphates and the subsequent dark reactions of CO_2 assimilation using these compounds is the new concept but how these reaction-conjugation mechanisms link up with the primary photochemical process occurring in chlorophyll remain largely speculative.

During the last decade Calvin and his collaborators using $C^{14}O_2$ showed that CO_2 reduction by plants resulted essentially in the formation of Ru-D-P subsequently converted into PGA (Figs. 4, 5). For one turn of the

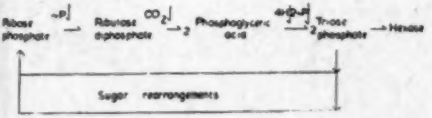


FIG. 4. Photosynthetic carbon cycle of Calvin (from Hill and Whittingham, 1958).

cycle one molecule of CO_2 is fixed and this requires the transfer of four hydrogen atoms and formation of three active phosphate groups. This double requirement has been shown with particulate preparations of spinach leaves. All the energy requirements for the operation of the cycle were present together with added ATP. No reaction occurred until the addition of one of the sugar phosphates as primer after which there was continued fixation of CO_2 and formation of hexose phosphate. A rapid decrease in CO_2 concentration was accompanied by a rapid fall in PGA and rise in RDP. This is a notable contribution as it is the first analytical study of changes in intermediates *in vivo* within times approaching those of individual reaction velocity constants.

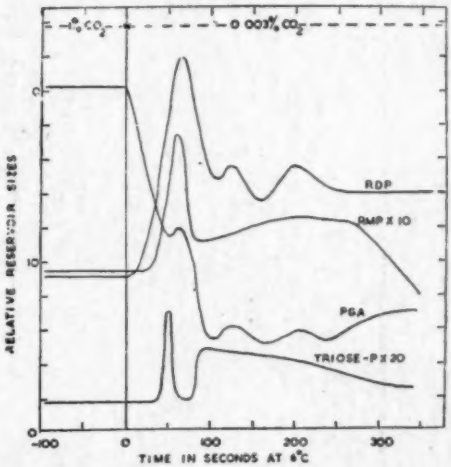


FIG. 5. Changes in the concentrations of phosphoglyceric acid, ribose, di- and mono-phosphate and triose phosphate consequent to a reduction in CO_2 concentration as shown by A. T. Wilson and M. Calvin (from Hill and Wittingham, 1958).

The nature of the enzyme systems taking part in the formation of the intermediates of the cycle of photosynthesis are being better understood now. In the green plant, Coenzyme II is postulated as the hydrogen acceptor for chloroplast functioning as a photochemical system. Coenzyme II reduction involves an intermediary which has been shown to be a soluble protein separable from the green insoluble system containing chlorophyll and cytochrome. The insoluble portion seems to possess the ability to initiate phosphorylation since H_2-acceptors could replace Coenzyme II and soluble protein (*see* Hill and Bendall). The chloroplast system seems to act by reversing a stepwise H_2 transfer and phosphorylation is a light reaction of a reductive nature against a thermochemical gradient. The emphasis laid by Hill and his collaborators is on a two step light-driven reaction involving cytochrome b_6 and f, somewhat analogous to hydrogen transfer characteristic of mitochondria. Admittedly, such a phosphorylation step between cytochrome b_6 and f has not found experimental evidence

in green plants. Indeed, one of the drawbacks of the Arnon scheme is that the properties ascribed to cytochromes do not seem to agree with their *in vitro* known properties but that is no argument to underestimate the major discovery that the rate of production of O_2 doubled in the presence of ADP, magnesium and inorganic phosphate. Therefore, it becomes obvious that, if it is asssumed that hydrogen (or electron) transfer is the basic mechanism by which cytochrome functions in chloroplasts, there ought to be more than one light-driven reaction acting against the thermochemical gradient.

The recent writings of Nichiporovich *et al.* (*see* Krasnovsky) indicate that relative rapidity of entry and subsequent distribution of labelled carbon in carbohyrates, amino-acids, organic acids and proteins vary with plant species, age, nutrition and intensity and spectral composition of the incident light. They claim that red light promoted increased carbohydrate formation while blue light promoted amino-acid and protein formation. These workers presume that this is attributable to the activation of cytochrome, flavin systems and respiration in blue light and its consequent effect on alteration of the ratio of oxidative to reductive reactions of photosynthesis. Be that as it may, it is quite obvious that, functioning carbon cycles must have an uninterrupted supply of products such as reduced pyridine-nucleotides and ATP, which, indeed, are resultant products of photochemical reactions. The active H_2 is lost by the reduced pyridine nucleotide in the carbon cycle and DPN (diphosphopyridine nucleotide) and TPN return to the system of photochemical reactions. Similarly, ADP returns to the photosynthetic phosphorylation cycle.

Deuterium (D_2O) and tritium (T_2O), the heavy hydrogen isotope and radioactive hydrogen, respectively, have been used alongside $C^{14}O_2$ in experiments on photosynthesis to understand the role of H_2 in the process. Accumulation of tritium was shown in glycolic, phosphoglyceric and glutamic acid in light experiments and in the dark, accumulation was greater in amino-acids. Much of the experimental work in this field remains inconclusive and generally point to the remote possibility of primary reversible dehydrogenation being the venue of participation of chlorophyll in photosynthesis. The use of heavy oxygen (O^{18}) in photosynthesis showed its accumulation in sugar phosphates and even here much work seems imminent if we were to understand the many mechanisms involved. However, the use of isotopes of H_2 or O_2 have so far yielded no tangible results and the mechanism of liberation of molecular oxygen which is the bed-rock of the phenomenon is still hypothetical. It has been suggested that intermediates of the oxidation of water resulting in the formation of molecular oxygen are evanescent and, since the process is a high velocity reaction, have defied detection. Despite all these results that have accrued by using isotope techniques, no decisive stand could be taken other than the path of carbon in photosynthesis being a multi-step cyclic process where CO_2 is bound by a compound (this according to Calvin is Ru-D-P subsequently converted into PGA) which is continually regenerated.

Summing up it could be stated that TPN-coupled phosphorylation, *i.e.*, synthesis of ATP, without evolution of O_2, is the new concept of Arnon that warrants attention and it has much experimental proof. Therefore, the conversion of light into chemical energy is fundamentally linked with phosphorus than with carbon. The view that efficient transfer of light energy into high-energy phosphate by a process recombination of products of photolysis cannot yet be thrown overboard. But in what way and how much of this high-energy phosphate is utilized in reduction of CO_2 may well have to be explained. Comparing chloroplast and chromatophore reactions there is undoubtedly similarity in the photophosphorylation process of both systems; in essence, it is an anaerobic process depending on electron transport between photochemical reductant and oxidant (Fig. 6).

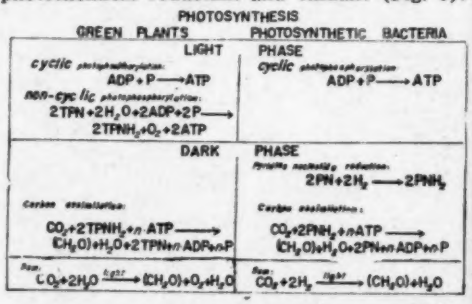

PHOTOSYNTHESIS
GREEN PLANTS
PHOTOSYNTHETIC BACTERIA
LIGHT PHASE
cyclic photophosphorylation:
ADP + P ⟶ ATP
non-cyclic photophosphorylation:
2TPN + 2H2O + 2ADP + 2P ⟶ 2TPNH2 + O2 + 2ATP
cyclic photophosphorylation
ADP + P ⟶ ATP
DARK PHASE
Pyridine nucleotide reduction:
2PN + 2H2 ⟶ 2PNH2
Carbon assimilation:
CO2 + 2TPNH2 + n ATP ⟶ (CH2O) + H2O + 2TPN + n ADP + n P
Carbon assimilation:
CO2 + 2PNH2 + n ATP ⟶ (CH2O) + H2O + 2PN + n ADP + n P
Sum:
CO2 + 2H2O ⟶ (CH2O) + O2 + H2O
Sum:
CO2 + 2H2 ⟶ (CH2O) + H2O

FIG. 6. Comparison of photosynthetic systems in green plants and photosynthetic bacteria (after Arnon, 1959).

However, the similarity exists only for the vitamin K pathway of cyclic photophosphorylation, the FMN pathway as well as the non-cyclic pathway being peculiar to chloroplasts. Therefore, with the recognition of cyclic photophosphorylation (vitamin K pathway) as

a common process to photosynthesis in green plants and photosynthetic bacteria, it is possible to omit photolysis of water as a common photochemical reaction. Thus, the evolution of O_2 by green plants is a consequence of some special way in which they form TPNH in light for which water is the hydrogen donor. To keep chlorophyll functioning, electrons removed by non-cyclic transport have to be continuously replenished possibly by electrons donated by the hydroxyl ions *via* a cytochrome chain and yielding molecular oxygen in the process (Fig. 3).

I have endeavoured to present much of what is known about photosynthesis in the hope that it would enthuse workers to study this fascinating subject from the biochemical, biophysical and physiological angles. It is a pleasure to acknowledge with thanks help of my colleagues: Drs. L. Saraswathi-Devi, D. Subramanian and S. Suryanarayanan for critical review of this manuscript.

1. Arnon, D. I., *Nature, Lond.*, 1959, **184**, 10.
2. Hill, R. and Whittingham, C. P., *Photosynthesis*, Methuen & Co., London, 1958.
3. — and Bendall, F., *Nature, Lond.*, 1960, **186**, 136.
4. — and —, *Ibid.*, 1960, **187**, 417.
5. Kandler, O., *Annu. Rev. Pl. Physiol.*, 1960, **11**, 37.
6. Krasnovsky, A. A., *Ibid.*, 1960, **11**, 363.

ADDENDUM

Since writing this up for the press an excellently written and fully illustrated article on the subject by D. I. Arnon has come to my notice (*Scientific American*, 1960, 203, 104). The reader would do well to peruse this. Much of the ground I have covered is what Arnon's latest article contains except that the non-cyclic photophosporylation referred to earlier as peculiar to green plants (*see* Fig. 6) has now turned out to be common for the photosynthetic bacteria also. However, the hydrogen donor in the latter case is not water but reducing substances like succinate.

Arnon has also added a philosophic note towards the end on "Photosynthesis and Evolution" which may be summarized as: When life appeared there was little oxygen in the atmosphere but had hydrogen as a free gas. In the same way as the bacterium *Chromatium* has been shown to be capable of making ATP in visible sunlight, the chlorophyll molecule, just evolved, is presumed to do in cells under anaerobic conditions. Thus, this vestige of a functional mechanism of cyclic photophosphorylation seems still to be retained by the aerobic plants we now see despite their ability in addition to make ATP through respiration. Then perhaps came a further evolutionary step, the non-cyclic process simulating the bacterial function of reducing pyridine nucleotide without using molecular hydrogen. The acme of perfection in photosynthesis eventually came from the ability of having water to donate the needed hydrogen and liberating oxygen into the atmosphere.

SYMPOSIUM ON COLLAGEN

A SYMPOSIUM on Collagen, sponsored by the Central Leather Research Institute, Madras, was held on the 29th and 30th November, 1960. Prof. M. S. Thacker, Director-General, Scientific and Industrial Research, India, inaugurated the symposium at a function presided over by Dr. A. Lakshmanaswamy Mudaliar, Vice-Chancellor of the Madras University. The inauguration was followed by the Conference lecture on "Structure of Fibrous Proteins and Polypeptides" by Prof. G. N. Ramachandran of the University of Madras. In this lecture, Prof. Ramachandran summarized the present state of knowledge on proteins and polypeptides, and dealt in detail with the structural problems associated with collagen and feather keratin.

Thirty-five papers were contributed to the symposium, and it may be noted that more than half the number came from scientists and technologists representing nine different countries of the world outside India.

In the first session on "Structural Studies" presided over by Dr. S. Ramaseshan of the Indian Institute of Science, Bangalore, ten papers were presented and discussed. Many proteins such as insulin, tobacco mosaic virus, myoglobin, etc., form single crystals; they have a specific sequence of amino-acid residues and are arranged in a perfect crystalline lattice array; their X-ray patterns show hundreds of sharp spots known in conventional X-ray crystallography. On the other hand, proteins like collagen, keratin, etc., form fibres and they differ from crystalline proteins not so much in their intrinsic chemical nature as in their physical state of aggregation. In fact it is this aggregation which endows collagen, for example, with those characteristic properties which make it an important biological building block. X-ray patterns of fibrous proteins show only a few diffraction streaks, and the elucidation of the structure is beset with difficulties. The

laws of geometrical crytallography have been worked out and well understood, but the laws of "fibre crystallography" are still in the process of being formulated.

The first breakthrough in our knowledge of the structure of collagen was made in 1954 when Ramachandran and Kartha gave their model of the triple helical structure. For stereochemical reasons Rich and Crick (1955) modified this structure by postulating the existence of only one cross-linking hydrogen-bond per three residues. In this symposium Ramachandran and his collaborators have again revived the original two-hydrogen-bond-per-three-residues structure with slight alterations. They have justified this structure from stereochemical criteria and claim that it satisfies all the X-ray and infra-red data. The structure of feather keratin is also shown to be of the collagen triple helix type.

The nine-residue-per-turn model was presented by Huggins (U.S.A.). An extremely interesting paper by A. R. Downie and A. A. Randall (England) showed from extensive data on mutarotation that there was a *cis-trans* isomerism of the peptide group—a fact which does not appear to corroborate Ramachandran's structure. The template theory and the role of collagen in the formation of bones and teeth, and the problem of collagen in silicosis were discussed by Seifert (Germany). Studies of the changes in X-ray diagrams of collagen derived from human tendon of different age groups, presented by Kratky (Austria), proved of interest as it dealt with the problem of old age.

In the second session on "Medical and Biochemical Studies" presided over by Dr. B. S. Gould of M.I.T. (U.S.A.), a variety of topics were dealt with in thirteen papers. Several papers were concerned with the structure of collagen, as deduced from analysis of the products obtained from it by enzymatic cleavage. Unusual linkages in collagen were described by Gallop (U.S.A.). Grassmann (Germany) postulated that the sequence P-R-Gly-P (where P stands for proline or hydroxyproline and R for an amino-acid) was attacked by collagenase. The stability of collagen was attributed by Banga (Hungary), to the existence of 'para-collagen' as, by removing this component, collagen fibres lost their strength.

Orekhovich (USSR) showed that the macromolecules of citrate-soluble procollagen consisted of two particles of the α-component and one of the β-component whereas in neutral salt-soluble procollagen, the β-component was present in small amounts.

Regarding biosynthesis of collagen, the occurrence of a proline-rich precursor, which was then converted by hydroxylation of the proline to collagen, was mentioned by Gould (U.S.A.). An adequate supply of ascorbic acid was necessary for collagen maintenance in so far as newly formed collagen was concerned. Collagen resorption occurred by some yet unclarified mechanism of collagenolysis. On the medical aspect of collagen research, it was reported that protein deficiency either inhibited the formation of fibrous tissue or promoted the disappearance of formed fibrous tissue in the liver.

Gustavson (Sweden) described the reaction of teleost and bovine skin collagen to specific agents and postulated the presence of covalent cross-linkages in bovine skin collagen. An analysis of gelatins (obtained from hides and bones) by Pouradier and Accary (France) showed that nucleic acids were bound to collagen.

In the third session on the "Physical, Chemical and Technological Studies" presided over by Dr. P. M. Gallop of Yeshiva University, New York, twelve papers were presented. Witnauer (U.S.A.) described the shrinkage of collagen and leather as a melting phenomenon. Basu discussed the effect of non-tans and lyotropic agents on the optical birefringence of tanned and modified collagen. A study on the relation between shrinkage and birefringence in the case of elastoidin was reported by Nayudamma and Ramanathan.

On the morphological aspects, a detailed analysis, by Nemetschek (Germany), of the cross-striations observed on collagen fibrils, treated in various ways, confirmed the accepted ideas on the evolution of collagen from tropocollagen particles.

Eucollagen reconstituted from bone was shown not to have the cross-striations exhibited by collagen fibrils reconstituted from other sources. A twisted appearance of the fibrils was recorded by Reed (U.K.) in some cases. The important point arose that the twisted appearance might be a reflection of the helical nature of the protofibrils.

The factors governing elastolysis were discussed. It was demonstrated by Hall (U.K.) that the reaction between elastase and elastin obeyed an unusual empirical relationship.

To summarize, the seminar had brought out, more than ever, the potentialities of research on collagen and emphasised that the number of sciences useful for investigations in this field was large.

LETTERS TO THE EDITOR

THE ELASTIC SCATTERING OF 426 Mev ELECTRONS BY LITHIUM-6

THE differential scattering cross-sections for the elastic scattering of 426 Mev electrons by Lithium has been experimentally obtained by Burleson and Hofstadter.[1] The experimental values are given in column II of Table I. They have also tried to explain the same on some standard nuclear models, but no single unique charge distribution for the nucleus of Lithium-6 could be formed.

It has been shown by Mathur and Gatha[2] that for a nonsingular electrostatic potential the scattering amplitude in the first Born approximation is given by

$$f(\theta) = -\frac{8\pi EZe^2}{(\hbar c)^2 A s^3}\int_0^\infty \rho(r)\sin(sr)\,r\,dr \qquad (1)$$

where,

$$s = 2k\sin\frac{\theta}{2},$$

while the other symbols have their usual meanings.

The above expression can be stated as

$$f(\theta) = -\frac{8\pi EZe^2A^{2/3}}{(\hbar c)^2 s'^3}\int_0^\infty \rho(r')\sin(s'r')\,r'\,dr' \qquad (2)$$

where,

$s' = sA^{1/3}$ and

$r' = rA^{-1/3}$

In the first Born approximation, the scattering cross-section for elastic scattering is given by

$$\sigma(\theta) = \left[1-\beta^2\sin^2\frac{\theta}{2}\right]|f(\theta)|^2 \qquad (3)$$

where,

$$\beta = \frac{v}{c}.$$

Now, from the study of high energy nucleon scattering by nuclei Gatha, Shah and Patel[3] have proposed the following characteristic nuclear density distribution for the light elements :

$$\rho(r') = \sum_{q=1}^{3} a_q \exp.(-\beta_q r'^2) \qquad (4)$$

where, $a_1 = 0{\cdot}25 \times 10^{39}$ cm.$^{-3}$
$a_2 = 0{\cdot}19 \times 10^{39}$ cm.$^{-3}$
$a_3 = 0{\cdot}1 \times 10^{39}$ cm.$^{-3}$
$\beta_1 = 28{\cdot}94 \times 10^{26}$ cm.$^{-2}$
$\beta_2 = 3{\cdot}83 \times 10^{26}$ cm.$^{-2}$
$\beta_3 = 0{\cdot}75 \times 10^{26}$ cm.$^{-2}$

This density distribution explains successfully the scattering of 340 Mev protons by Ca, Al, etc. It also explains the scattering of 125 Mev electrons by Be as shown by Gatha, Patel and Patel.[4]

Later on, Gatha and Shah[5] have proposed an improved characteristic nuclear density distribution for light elements as given below :

$$\rho(r') = a_1\exp.(-\beta_1 r'^2) + a_2\exp.(-\beta_2 r'^2) \times \{1-\beta_3 r'^2 + \beta_4 r'^4\} \qquad (5)$$

where, $a_1 = 0{\cdot}12 \times 10^{39}$ cm.$^{-3}$
$a_2 = 0{\cdot}25 \times 10^{39}$ cm.$^{-3}$
$\beta_1 = 8{\cdot}62 \times 10^{26}$ cm.$^{-2}$
$\beta_2 = 1{\cdot}09 \times 10^{26}$ cm.$^{-2}$
$\beta_3 = 0{\cdot}44 \times 10^{26}$ cm.$^{-2}$
$\beta_4 = 0{\cdot}13 \times 10^{52}$ cm.$^{-4}$

On the basis of this improved density distribution Gatha, Shah and Advani[5] have successfully explained the elastic scattering of 125 Mev and 190 Mev electrons by Be.

We have calculated the differential scattering cross-sections of 426 Mev electrons by Li-6 using both the above density distributions. The results on the basis of density distribution given in equation (4) are stated in column III of Table I and those on the basis of improved density distribution given in equation (5) are stated in column IV of Table I. It can be seen that neither of the density distributions gives the values agreeing with the experimental values.

TABLE I

Differential scattering cross-sections for 426 Mev electrons by Li-6

I	II	III	IV	V
θ	(Experimental values[1]) $\sigma(\theta)\times10^{-32}$	(Gatha *et al.*[3]) $\sigma(\theta)\times10^{-32}$	(Gatha and Shah[5]) $\sigma(\theta)\times10^{-32}$	(Authors' values) $\sigma(\theta)\times10^{-32}$
33°	149	278·34	404·28	155·2
35°	91·4	170·22	256·72	91·77
37·5°	43·1	90·93	148·30	47·41
40°	24·1	50·84	87·04	24·41
41·25°	17·7	38·49	67·14	17·42
42·5°	11·4	29·18	52·15	12·47
45°	6·45	10·85	31·53	6·32
47·5°	2·59	10·44	19·42	3·20
50°	1·49	6·48	12·06	1·79
52·5°	0·776	4·20	7·58	0·777
55°	0·330	2·78	4·78	0·389
57·7°	0·211	2·23	2·99	0·177

Hence we propose a density distribution as shown below:

$$\rho(r') = a \exp.(-\beta r'^2) \qquad (6)$$

where, $a = 0{\cdot}13 \times 10^{39}$ cm.$^{-3}$

$\beta = 1{\cdot}05 \times 10^{26}$ cm.$^{-2}$

The calculated differential scattering cross-sections on the basis of proposed nuclear density distribution is given in column V of Table I. It can be seen that the calculated values of the differential cross-sections agree to a very large extent with the experimental results.

Physics Department, N. J. PATEL.
M.G. Science Institute, C. M. BHAVSAR.
Ahmedabad-9, *December* 21, 1960.

1. Burleson, G. R. and Hofstadter, R., *Phys. Rev.*, 1958, **112**, 1282.
2. Mathur, A. L. and Gatha, K. M., *Proc. Phys. Soc.*, 1953, **66 A**, 773.
3. Gatha, K. M., Shah, G Z. and Patel, N. J., *Ibid.*, 1954 **67**, 773.
4. —, Patel, N. J. and Patel, P. F., *Ibid.*, 1954, **67**, 1111.
5. Advani, M. K., Shah, G. Z. and Gatha, K. M., *Curr. Sci.*, 1955, **11**, 367.

CRYSTAL STRUCTURE DATA OF SOME RHODITES AND RUTHENITES

RUDORFF AND REUTER[1] investigated the crystal structures of $MgRh_2O_4$ and $ZnRh_2O_4$ and found that they were normal spinels. Recently Bertaut *et al.*[2] published data on crystal structure of rhodites of Mg, Zn, Cd, Mn, Co, Ni and Cu. In this article data on crystal structures of rhodites of Mg, Zn, Cd, Mn, Cu, Fe, Cr, La and Li and strontium ruthenite are presented.

The rhodites and ruthenites were prepared by firing an intimate mixture of rhodium or ruthenium metal and a metal oxide or carbonate in an atmosphere of pure dry oxygen in a Johnson Mathey platinum-rhodium wound furnace giving a maximum working temperature of 1350° C. The compositions of the products were determined on the basis of the oxygen intake of rhodium or ruthenium metal as determined by increase in weight of the product. From X-ray powder photographs obtained in a 9 cm. Bradley[3] camera the unit cell dimensions were determined by standard methods.

The results are summarized in Table I. The data of other workers are given in the last column for comparison.

The crystal structure data show that rhodites of Mg, Zn, Cd, Mn and Li are cubic spinels. Lithium and Manganic rhodites appear to have a defect structure like that of $\gamma - Fe_2O_3$. Copper rhodite is a tetragonal spinel with negative deformation ($c/a < 1$). Ilmenite structure is shown by rhodites of Fe and Cr while Lanthanum rhodite and Strontium ruthenite possess the perovskite structure. Attempts to prepare other ruthenites did not meet with success. It will be seen that the results of the author are in general agreement with those of other workers.

The work described in this article was carried out by the author in 1953-54, during the tenure of a Government of India scholarship at the Imperial College of Science and Technology,

TABLE I
Table of results

Element other than Rh or Ru	Supposed valency of Rh or Ru	Product	Symmetry	Lattice constant	
				Author	Other workers
Magnesium	3	$MgRh_2O_4$	Spinel	$a = 8{\cdot}51$ Å	$8{\cdot}53^2$ $8{\cdot}51^1$
Zinc	3	$ZnRh_2O_4$	do.	$a = 8{\cdot}52$ Å	$8{\cdot}54^2$ $8{\cdot}52^1$
Cadmium	3	$CdRh_2O_4$	do.	$a = 8{\cdot}76$ Å	$8{\cdot}78^2$
Manganese (II)	3	$MnRh_2O_4$	do.	$a = 8{\cdot}60$ Å	$8{\cdot}61^2$
do. (III)	3	$MnRhO_3$	do.	$a = 8{\cdot}57$ Å	..
Copper (II)	3	$CuRh_2O_4$	Tetragonal Spinel	$a = 8{\cdot}72$ Å $c = 8{\cdot}29$ Å	$8{\cdot}70^2$ 7·91
Lithium	3	$LiRhO_3$	do.	$a = 8{\cdot}46$ Å	..
Iron (III)	3	$FeRhO_3$	Ilmenite	$a = 5{\cdot}46$ Å $\alpha = 55°26'$	..
Chromium (III)	3	$CrRhO_3$	do.	$a = 5{\cdot}42$ Å $\alpha = 55°12'$	.. ..
Lanthanum	3	$LaRhO_3$	Perovskite	$a = 3{\cdot}94$ Å	..
Strontium	4	$SrRuO_3$	do.	$a = 3{\cdot}93$ Å	..

London, under the direction of Dr. A. J. E. Welch.

D. D. KHANOLKAR.

Institute of Armament Studies,
Kirkee, Poona-3, *November* 25, 1960.

1. Rudorff and Reuter, *Z, anorg. Chem.*, 1947, **253**, 194.
2. Bertaut *et al.*, *Compt. rend.*, 1959, **249**, 726.
3. Bradley *et al.*, *J. Sci. Instruments*, 1941, **18**, 216.

A PRELIMINARY STUDY OF THE CRYSTAL STRUCTURE OF La_2Mg_3 $(NO_3)_{12}.24\ H_2O$

IN view of the stimulating interest, in recent years, in the paramagnetic resonance studies (involving rare-earth double nitrates) in the solid state, work on the crystal structure determination of Lanthanum Magnesium Nitrate was undertaken at the suggestion of Professor B. Bleaney of Clarendon Laboratory, Oxford.

It is well known that the double nitrates of rare-earths form an isomorphous series of the formula A_2B_3 $(NO_3)_{12}.24\ H_2O$ where A is the trivalent rare-earth ion and B is a divalent metal such as Mg or Zn. The external morphology of the various members of the series has been described by Groth (1908) who has classified them as 'trigonal' with axial angle close to 80°.

Details of the crystal structure of these compounds are unknown. However, Powell (unpublished), at Oxford, has determined the structure of the lattice formed by the cerium ions in cerium magnesium nitrate: the cerium atoms lie on a rhombohedral lattice with a unit cell of side 8·51 Å and interaxial angle of 79·5° (*see* Cooke *et al.*, 1953).

Crystals of La_2Mg_3 $(NO_3)_{12}.24\ H_2O$, suitable for X-ray analysis, were obtained by mixing La $(NO_3)_3.6\ H_2O$ and Mg $(NO_3)_2.6\ H_2O$ in the ratio 2 : 3 and crystallizing the resulting mixture from aqueous solution; the crystals came down readily as thick plates. On closer examination, they were found to be deliquescent; as a consequence they were sealed in special Lindemann capillaries for X-ray photography.

Oscillation and Weissenberg photographs about the hexagonal and rhombohedral axes revealed an interesting feature; the observed reflexions *hkl* were all 'even, even, even' or 'odd, odd, odd'; of these 'odd, odd, odd's were, in general, very weak while the 'even, even, even's were consistently strong. This would suggest that the substance crystallizes in the 'face-centred' lattice.

In view of the fact that the strong diffraction intensities could, with good approximation, be attributed to the heavy atoms (since the scattering power of Mg, N and O is very small compared to La) the lattice formed by the Lanthanum atoms were deduced primarily from the strong layer-line separation on the oscillation photographs along the hexagonal '*a*' and '*c*' axes as:—

$a = 10{\cdot}91$ Å, $c = 17{\cdot}35$ Å } hexagonal lattice.

$a = 8{\cdot}53$ Å, $\alpha = 79{\cdot}5°$ } rhombohedral lattice.

Moreover, the angle between the hexagonal c-axis and the rhombohedral cell-edge was found to be 47·3°.

The lattice parameters were confirmed by the oscillation and Weissenberg photographs along the rhombohedral axis which gave the values:

$$a = 8{\cdot}55\ \text{Å}; \qquad \alpha = 79{\cdot}8°.$$

It therefore seemed reasonable to conclude that the Lanthanum atoms lie on a rhombohedral lattice with a unit cell of side 8·54 Å and interaxial angle of 79·7°.

However, the oscillation photograph about the rhombohedral axis showed intermediary *weak* layers corresponding to an 'identity period' of 17·1 Å. At this stage, the density was determined by the method of 'flotation' which gave a value of 1·95 g. cm.$^{-3}$ (at 20° C.); this seemed to require 4 molecules in the unit cell taking into account the weak odd-layers as well.

In view of the fact that each molecule is essentially comprised of 77 atoms (2 La, 3 Mg, 12 N and 60 O's; excluding H's) it seems advisable to attempt a three-dimensional analysis to elucidate the structure fully. This entails the collection of the 'intensity data' for all the possible layers (15) with equi-inclination angles less than 40°, around the rhombohedral axis. Part of the Weissenberg data, *viz.*, for the zero, 1st, 2nd and 3rd layers have already been collected. The details of the analysis will be published elsewhere.

Physics Department, S. N. DUTTA.
Lucknow University,
Lucknow, *December* 22, 1960.

1. Groth, P., *Chemische Kristallographie*, 1908, **2**, 156.
2. Cooke, A. H., Duffus, H. J. and Wolf, W. P., *Phil. Mag.*, 1953, **44**, 623.

THE SEPARATION OF URANIUM FROM CRUDE SODIUM-DIURANATE BY PHOTOLYSIS

THE application of the photolytic method[1-3] for the recovery of uranium from the commercial sample of sodium-diuranate is presented in this note.

The crude sample of diuranate was first treated with nitric acid (1 : 1) over a sand-bath with constant stirring. Filtration was carried out after dilution, when the residue became gelatinous and did not go into solution any further. The filtrate was made up to a fixed volume and was used as stock solution. Definite volumes of the stock solution were taken for the determination of the uranium content by two different methods, *viz.*, by extraction with ethyl ether and by the photolytic method. The extraction with ethyl ether was carried out according to the procedure followed by E. Peligot.[4] The amount of uranium obtained by the ether extraction was taken as the standard for comparison with the product recovered from the photolytic process. In the photolytic separation, ammonium-bifluoride was first added to an aliquot of the stock solution, when the insoluble metal fluorides were filtered off. The pH of the solution was next adjusted to 2·5 after which alcohol was added to the extent of 20% by volume. The solution thus prepared was exposed to sunlight for 5-6 hours. The precipitated fluoride complex[5] of uranium was filtered off and analysed in the manner described previously (*loc. cit.*). Uranium recovered by the two methods (Table I) is almost the same

TABLE I

Recovery of uranium by single and double stage photolysis

Weights in mg.

Recovery from ether extract calculated as U_3O_8	Oxide obtained from the product	Jone's reductor value calculated as oxide	Percentage of yield	Percentage of purity
2·030	2·040	2·032	100	99·61
(2·030)	(1·990)	(1·992)	(98·04)	(100)
2·028	2·038	2·027	100	99·47
(2·028)	(1·986)	(1·982)	97·92	(100)

Note: Figures in brackets are for double stage photolysis.

except for the fact that the product obtained by single stage photolysis is of 99·5% purity. To increase the purity, the photolysis was carried out for a second time after dissolving the fluoride complex in dilute nitric acid. The data for the product of two-stage photolysis recorded in brackets show that the uranium obtained is chemically pure. The recovery of uranium after the second stage photolysis is about 98%; and the filtrate obtained containing 2% of the uranium can be used with the fresh sample of crude diuranate thus avoiding any loss of uranium.

The photolytic method outlined above offers an alternate procedure to the standard ones in practice for the separation of uranium in a chemically pure state, as it involves extremely simple operations and also as it utilises sunlight available in abundance throughout the year in our country.

Ravenshaw College, D. PATNAIK.
Utkal University, K. SINGH.
Cuttack-3, *September* 22, 1960.

1. Singh, K., Sahoo, B. and Patnaik, D., *Proc. Ind. Acad. Sci.*, 1959, **50 A**, 129.
2. — and Patnaik, D., *Ibid.*, 1959, **50 A**, 358.
3. —, Sahoo, B. and Patnaik, D., *J. Sci. Industr. Res.*, 1960, **19 B**, 31.
4. Peligot, E., *Ann. Chem. Phys.*, 1842, **5**, 5.
5. Sahoo, B. and Patnaik, D., *Curr. Sci.*, 1959, **28**, 195.

SYNTHESIS OF 4:5-DIHYDROXY-COUMARIN: A RARE OBSERVATION OF TOTAL γ-SUBSTITUTION IN RESORCINOL

MENTZER and Vercier[1] carried out the thermal condensation of phenols with substituted malonic esters and obtained 3-substituted-4-hydroxy-coumarin derivatives. It is now observed that when the same reaction is carried out in refluxing diphenyl ether corresponding 3-substituted-4-hydroxy-coumarin derivatives are obtained in good yields.

When resorcinol is condensed with ethyl methylmalonate it furnishes 3-methyl-4 : 7-dihydroxycoumarin as obtained by Mentzer *et al.* But when it is condensed with ethyl benzylmalonate in refluxing diphenyl ether, 3-benzyl-4 : 5-dihydroxycoumarin, m.p. 259-60°C. (Found : C = 71·99, H = 4·56; $C_{16}H_{12}O_4$ requires C, 71·64, H, 4·48%) is obtained in good yield. This compound underwent debenzylation when heated with anhydrous aluminium chloride at 200° C. for 15 min. to give 4 : 5-dihydroxycoumarin, m.p. 221°C. The structure of this compound was confirmed by direct comparison with an authentic sample of 4 : 5-dihydroxycoumarin prepared according to the method of Desai and Sethna.[2] Recently Vallet and Mentzer[3] carried out the above condensation and obtained 3-benzyl-4 : 7-dihydroxycoumarin, m.p. 245° C. This is a rare

observation in which total γ-substitution in resorcinol has taken place without the use of condensing agent and furnishes an easier method for the synthesis of 4 : 5-dihydroxy-coumarin. Details of the condensation of phenols with substituted malonic esters in refluxing diphenyl ether will be published elsewhere.

Author's thanks are due to Prof. S. M. Sethna for his valuable guidance and help and also to Shri S. S. Lele for carrying out the micro-analysis.

Chemistry Department, K. N. Trivedi.
Faculty of Science,
Baroda-2, *October* 21, 1960.

1. Mentzer C. and Vercier, P., *Compt. rend.*, 1951, 232, 1674.
2. Desai, N. J. and Sethna, *J. Org. Chem.*, 1957, 22, 388.
3. Mentzer, C. and Vallet, *Compt. rend.*, 1959, 248, 184.

A NOTE ON THE FATTY OIL OBTAINED FROM *NIGELLA DAMASCENA* SEEDS

Nigella damascena L. (Natural Order : Ranunculaceæ ; English : Damaskfennel ; German : Türkischer Schwarzkümmel) was cultivated in Central Europe as far back as 16th century. The plant has its habitat in the Mediterranean regions and in Asia Minor.[1] The ripe seeds of the plant which are black in colour were earlier used in these countries as a household remedy. In homeopathy a tincture[2] prepared from the ripe seeds by percolation finds application as a remedy against catarrhal inflammations of liver and intestines. The seeds are also said to be effective as carminative, emmenagogue as well as anthelmintic. The plant grows wild and it also serves as a favourite garden flower. It is not found in India, though a closely related species *Nigella sativa* L. (Hindi : Kalonji, Kalajira) is cultivated in this country and used as a spice.[3] A search made into the past literature on the chemical investigation of the seeds of *N. damascena* revealed that the drug contained an alkaloid Damascenine ($C_{10}H_{13}NO_3$), most of which is present in testa, a saponin type of glycoside ($C_{20}H_{33}O_7$) called Melanthine, and a blue fluorescent essential oil.[4] During the course of investigations carried out at the University of Halle-Wittenberg (Germany) on the biochemical[5,6] and pharmacological aspects of the plant it was found that large proportion of fatty oil was present in the seeds which may possibly find some application in industry. The fixed oil appears hitherto not to have been chemically characterised as per literature available.

A detailed analysis carried out on several samples of the drug procured from different sources showed that it contained (average values) 7·82% moisture (based on dry weight), and 3·9% total ash (based on dry weight) while 0·14% of the total ash comprised its acid insoluble portion. The extraction of powdered seeds (seeds supplied by Deutscher Saatgut-handelsbetrieb—Germany) with petroleum ether (B.P. 30–50° C.) in a soxhlet yielded a fatty oil content of 43·5%, based on the weight of air-dried drug. The yellowish-brown oily liquid possessed an aromatic odour and exhibited an intense blue fluorescence under filtered ultra-violet light. On keeping it for a long time it deposited a solid white mass. The following constants were determined employing the usual methods in order to chemically characterise the fatty oil thus obtained :—

1.	Specific gravity	0·919 at 22° C.
2.	Congealing point (Pharm. Germ. 6th).	−3° to −4° C.
3.	Refractive index : (Zeiss Refracto-meter)	1·476 at 20° C.
4.	Saponification value	193
5.	Acid value	59·7
6.	Acid number	106·4
7.	Ester value	133·3
8.	Iodine value (Kaufmann) ..	116·18
9.	Butyric acid value	1·26
10.	Reichert-Meissl value	2·50
11.	Polenske value	0·35
12.	Unsaponifiable	1·88%
13.	Glycerine content (calculated) ..	7·29%

Percentage of total fatty acids contained in the oil was 97·08, while the percentage of free fatty acids amounted to 30·03.

From the above data it is clear that the fatty oil obtained from the seeds of *N. damascena* has an abnormally high acid value, though in most of the other constants it compares well with those of cotton-seed oil.[7] The seeds of *N. damascena* have been shown to contain Lipase,[8,9] the presence of which might explain for the unusually high acid value of the oil. It is inferred that the fatty oil of the drug can be grouped under semi-drying oils and could possibly be employed in the soap industry. Further work in regard to the determination of the exact composition of fatty acids is now in progress and will be reported in due course.

My grateful thanks are due to Prof. K. Mothes, Director, Pharmacognostical Institute, University

of Halle-Wittenberg (Germany), for his keen interest in the work.

Division of Pharmacy, MOHAN L. VISHIN.
Birla College of Pharmacy & Science,
Pilani (Rajasthan), *October* 25, 1960.

1. Hoppe, H. A., *Handbuch der pflanzlichen und tierischen Rohstoffe*, 7th Edition, Hamburg, 1958.
2. *Homöopathisches Arzneibuch*, 2nd Edition, Berlin, 1950.
3. Chopra, R. N., Nayar, S. L. and Chopra, I. C., *Glossary of Indian Medicinal Plants*, Council of Scientific and Industrial Research, New Delhi, 1956.
4. Vishin, M. L., *Ph.D. Thesis*, University of Halle, 1960.
5. Hannig, E. and Vishin, M. L., *Planta Medica*, (Stuttgart), 1960, **8**, 183.
6. Vishin, M. L., *et al.*, *Nature* (*Lond.*), 1960 (in press).
7. *British Pharmacopœia*, The Pharmaceutical Press, London, 1958.
8. Tietz, N., *Biochem. Z.*, 1954, **325**, 123.
9. Ullmann, E., *Pharmazie*, 1959, **14**, 57.

A STUDY OF THE ROCKS AT PANDAVA FALLS IN PANNA STATE, M.P.

PANDAVA Falls is situated nearly seven miles away from Panna township on Chatterpur road between the latitude 24° 45′ and longitude 80° 5′, at a mean altitude of 874 ft. above sea-level.

F. R. Mallet mapped this area in detail and came to the conclusion that the rocks belonged to Kaimur Series. Just below the fall we come across massive rock having fine matrix. It contains a considerable amount of pebbles of varying shapes and sizes, majority of these being large in size. These pebbles are mostly elongated, but the matrix in which they are embedded is compact and seems to have been metamorphosed to some degree. Undoubtedly some pebbles are lens-shaped and exhibit rough orientation but the feature of polishing is seldom prominent.

Dubey and Chaudhary[1] while working in Sone and Ken valley respectively concluded that Central India suffered glaciation in the late pre-cambrian times together with Australia, China and S. Africa. Mathur[2] contradicted this view and proved that the mere presence of fresh-Feldspars in the matrix is no evidence of glaciation unless there are other supporting features. Auden[3] also rules out the possibility of glaciation in this period.

Ahmed,[4] while agreeing that the rocks are Kaimurs, has tried to attribute glacial origin to them merely on account of the fact that it contains large boulders in the fine matrix with no evidence of sorting or bedding.

This formation is however overlain by a thin band of conglomerate which passes upward into what is considered as varvites by some advocates of glaciation. I can safely say that it is not varvite but thin-bedded sandstone, as there is no possibility of getting varvites under Fluviatile conditions. Close study shows that this layering and friable nature are the outcome of the climatic fluctuations in that period. This thin-bedded sandstone is further overlain by compact sandstone which shows occasional occurrence of ripple marks and rain-drop impressions and has got practically horizontal dip.

Barrel regarded the old Red sandstones of Britain as Fluviatile deposits formed along flood plains in intermontane basins, subject to seasonal rainfall and semi-arid conditions. These characters are similar to those found in Kaimur sandstones and hold good for this formation as well.

I therefore regard that these rocks below the Pandava Falls were deposited under fluviatile conditions and belong to Kaimurs. And this so-called tillite is nothing but Breecia deposited under fluviatile conditions which marks an unconformity between Kaimurs and underlying rocks.

H. B. SAXENA.
Dept. of Geology, C.S.I.R. Research Fellow.
Aligarh Muslim University,
Aligarh, *December* 19, 1960.

1. Dubey, V. S. and Chaudhary, M. S., *Curr. Sci.*, 1952, **21**, 331.
2. Mathur, S. M., *Ibid.*, 1954, **23**, 7.
3. Auden, J. B., *Mem. G.S.I.*, **62**.
4. Ahmed, F., *Curr. Sci.*, July 1955, **24**, 231.

EFFECT OF LUCERNE SUPPLEMENT TO THE RICE DIET ON CIRCULATING HAEMOGLOBIN AND PLASMA PROTEINS OF RATS*

SUBRAHMANYAN AND SUR[1,2] reported that the rate of growth of rats receiving the poor rice diet increased three-fold when desiccated lucerne (*Medicago sativa* Linn.) leaf flour was included in the diet at 10 or 4% levels. Considering the amount of supplement fed, the increase in growth rate was remarkable. Preliminary trials showed that although the animals in the two groups grew at very different rates, there was not much difference in the R.B.C. count and hæmoglobin concentration in the blood of the two groups of animals. It was of interest therefore to study the effect of

lucerne supplements on the blood volume and total circulating hæmoglobin and plasma proteins.

Two groups of freshly weaned rats (4 males and 4 females in each group), weighing 40-50 g. and comparable with respect to age, weight, sex and litter, were fed *ad libitum* for a period of 8 weeks on (i) the poor rice diet and (ii) the same diet in which rice was replaced to the extent of 4% by an equivalent quantity of dry lucerne leaf flour. At the end of the experimental period, blood was drawn from the tail end and hæmoglobin estimated by the acid hematin method using photoelectric colorimeter. Blood volume was next determined by the Evans blue injection method as described by Metcoff and Favour.[3] 0·3 ml. of the dye solution was injected through the right jugular vein and after 3 minutes, blood was withdrawn from the abdominal vein. After determining hæmatocrit, 0·2 ml. of plasma was diluted to 5 ml. with isotonic saline solution and the concentration of the dye estimated in a photoelectric colorimeter. Total nitrogen in plasma was determined in 0·1 ml. plasma samples by the micro-kjeldahl method. As sufficient blood could not be drawn from two female rats in group I, data obtained with six animals in each group are presented in Table I.

TABLE I

Effect of lucerne supplement on blood volume and circulating hæmoglobin and plasma proteins of rats

	Poor rice diet (Group I)	Poor rice diet +4% lucerne (Group II)	Significance
Body weight (g.) ..	76	121	..
Hæmoglobin	15·1±	15·3±	..
(g./100 ml. blood)	0·51	0·24	
Total plasma nitrogen	923±	926±	..
(mg./100 ml. plasma)	22·7	15·3	
Hæmatocrit ..	41±	43±	..
	1·5	1·5	
Plasma volume	2·9±	3·8±	†
(ml./100 g. body wt.)	0·17	0·21	
Blood volume	5·0±	6·6±	*
(ml./100 g. body wt.)	0·32	0·43	
Circulating Hæmoglobin	0·76±	1·01±	*
(g./100 g. body wt.)	0·062	0·074	
Circulating Plasma	27·1±	34·8±	†
nitrogen (mg./100 g. body wt.)	1·14	1·97	

* Significant at 5% level. † Significant at 1% level.

It would be seen from Table I that there is no difference in the concentration of hæmoglobin and plasma nitrogen in animals of both groups. However, in the case of animals receiving lucerne supplements, there is a significant increase in plasma and blood volumes (per 100 g. body weight) with a consequent increase in total circulating hæmoglobin and total circulating plasma proteins per 100 g. body weight. In the case of rats receiving the poor rice diet, the circulating hæmoglobin and plasma proteins are lower. This is not apparent from their concentration owing to decrease in blood volume.

Author's thanks are due to Dr. V. Subrahmanyan, Director, Central Food Technological Research Institute, Mysore, for valuable advice during the course of the work.

G.S.V.M. Medical College, Kanpur, *October* 7, 1960. B. K. SUR.

This work was done by the author in the Central Food Technological Research Institute, Mysore.

1. Subrahmanyan, V. and Sur, B. K., *Ind. J. Med. Res.*, 1949, **37**, 319.
2. Sur, B. K. and Subrahmanyan, V., *Curr. Sci.*, 1954, **23**, 188.
3. Metcoff, J. C. and Favour, E., *Amer. J. Physiol.*, 1944, **141**, 695.

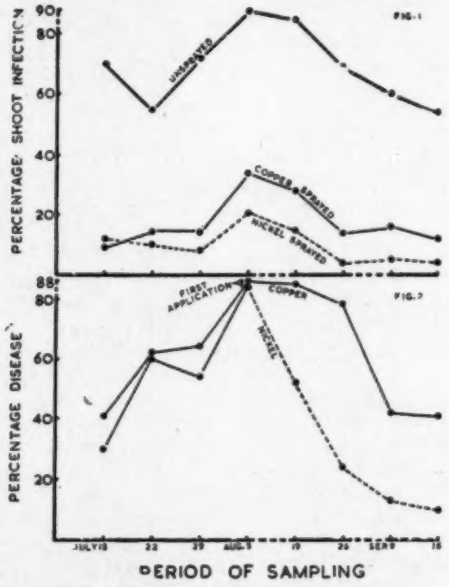
APPLICATION OF NICKEL CHLORIDE TO TEA PLANTS (*CAMELLIA SINENSIS*) AND CONTROL OF BLISTER BLIGHT

A LEAF disease of tea plants incited by *Exobasidium vexans* Massee, commonly known as blister blight, affects an area over 150,000 acres in Southern India and, indeed, is perhaps the most serious single problem in tea cultivation. Ever since the outbreak of the disease in 1946, numerous inorganic and organic fungicides have been tested[1-3] but none gave disease control superior to that achieved with copper fungicides. Similar results were also obtained in Ceylon.[4] Method in vogue for blister blight control involves protective spraying (or dusting) with copper fungicides at 7-10 day intervals. Consequent on the striking success recently reported with nickel compounds against cereal rusts,[5,6] both as protective as well as eradicative fungicides, field trials were carried out with nickel chloride to test its efficiency in controlling blister blight and results are reported here.

The experimental lay out was of a randomized block design with quadruplicate plots, each with ten tea bushes, in a treatment. A proven cuprous oxide (Perenox) and nickel chloride hexahydrate were sprayed at the rate of 6 oz. in 15 gallons of water per acre at 7-day intervals. Pressure retaining knapsack sprayers fitted with a low volume nozzle were employed and fungicide application followed soon after plucking. In two other treatments the plots

were allowed to develop a very heavy initial infection, after which in one treatment copper oxychloride at 6 oz. and in the other nickel chloride at 3 oz. per acre were sprayed. Disease assessment was made weekly by determining the number of shoots infected in a lot of 100, selected at random from the total number of shoots plucked in each plot and from this percentage disease calculated with reference to the control.

With the exception of the first sampling, percentage shoot infection was throughout lower in nickel chloride than in the cuprous oxide treatment (Fig. 1). Infection was 8-13% higher



FIGS 1 and 2 showing the influence of nickel spray on blister blight disease of tea plants. Fig. 1 gives percentage shoot infection in unsprayed. copper and nickel sprayed plots. In Fig 2 the rate of decline of percentage disease in nickel-treated plots, which had initially high blister blight infection, is compared to that in copper treated plots.

in cuprous oxide treatment when compared to nickel chloride in the last four assessments. The metallic content of the two fungicides was 50% copper and 25% nickel and, therefore, at the concentrations used, 3 oz. copper and 1·5 oz. nickel were applied per acre. In the other experiment intended to test the eradicative activity of nickel, 3 oz. nickel chloride (0·75 oz. nickel) sprayed on plots with an average initial infection of 84% reduced the disease to 24 and 13% after 3 and 5 weekly applications, respectively. In a parallel treatment 6 oz. of copper oxychloride (3 oz. copper) failed to give such striking disease control (Fig. 2). An important point emerging out of these results is that nickel in concentration equivalent to one-fourth that of copper seemed to be markedly superior to copper in controlling blister blight. Reports from tea tasters indicate that nickel chloride does not taint tea. Tests with other nickel salts are being carried out and details will be published elsewhere.

Tea Experiment Station, C. S. VENKATA RAM.
Devarshola, The Nilgiris,
S. India, *September* 19, 1960.

1. de Jong, P., *UPASI Sci. Dep. Tea Sect. Bull.*, 1956, **15**, 2.
2. Jayaraman, V. and Venkataramani, K. S., *Planters' Chronicle*, 1957, **52**, 35.
3. Venkata Ram, C. S. and Jayaraman, V., *A.R. UPASI Sci. Dep. Tea Sect. Bull. for 1959–60*, 1960, 36
4. Park, P. O. and Webster, B. N., *Tea Quart.*, 1956, **27**, 14; Visser, T., Shanmugan. than, N. and Sabanayagam, J. V., *Ibid.*, 1958, **29**, 9.
5. Forsyth, F. R. and Peturson, B., *Plant Dis. Reptr.*, 1959, **43**, 5.
6. Keil, H. L., Frohlich, H. P. and VanHook, J. O., *Phytopathology*, 1958, **48**, 652; Peturson, B., Forsyth, F. R. and Lyon, C. B., *Ibid.*, 1958, **48**, 655; Keil, H. L., Frohlich, H. P. and Glassick, C. E., *Ibid*, 1958, **48**, 690; Forsyth, F. R. and Peturson, B., *Ibid.*, 1959, **49**, 1.

FOLIN-PHENOL REAGENT FOR THE MEASUREMENT OF LEAF PROTEINS

IN an investigation of fractionation of leaf proteins, a suitable method of measuring protein contents of fractions was to be considered. Use of trichloracetic acid to precipitate protein and further digestion with acid and nesslerization is the method of choice in most enzyme-protein studies, although a quite time-consuming one. However, where both rapidity and sensitiveness are needed (especially when replicated samples are to be studied) Folin-phenol reagent method is found more useful (Lowry *et al.*, 1951).

One main disadvantage of the Folin-phenol reagent method is that the colour developed is not strictly proportional to concentration, in all cases. It was therefore felt necessary to find out if a straight line curve relationship could be obtained with leaf proteins using this method. This was tested as below:

One gramme leaf tissue was homogenised in water, made to 50 ml. volume and filtered through four folds of cheese cloth. The filtrate was mixed well and 1, 2, 3, 4 and 5 ml. aliquots diluted to 50 ml. volume. After shaking well, 1 ml. of

each of the diluted leaf homogenate was taken in a test-tube to which 5 ml. of protein reagent (Folin) was added. The mixture was maintained at 37° C. in a water-bath. Later, 0·5 ml. of phenol reagent was added and shaken vigorously immediately. Again the mixture was maintained at 37° C. for 20 minutes. Optical density of blue colour developed was measured at the end of 20 minutes as early as possible, against reagent blank, at 650 mμ in the Beckman model B spectrophotometer. Concentration of protein was then calculated by referring to a standard curve prepared using pure casein solution. The instrument readings and the curve obtained by plotting concentration against optical density are given below respectively in Table I and Fig. 1.

TABLE I

Relationship between concentration of leaf proteins and optical density of the colour developed with Folin-phenol reagent

	Concentration	Optical density at 650 mμ
1	ml. leaf homogenate ..	0·0350
2	do. ..	0·0725
3	do. ..	0·1100
4	do. ..	0·1450
5	do. ..	0·1780

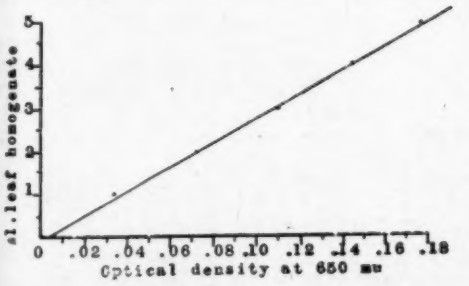


FIG. 1. Relationship between concentration of leaf proteins and optical density of the colour developed with Folin-phenol reagent.

The optical density of the blue colour developed is thus found to be linear with the concentration of leaf proteins. Several hundred measurements of leaf proteins were made using this method. Results have been quite satisfactory in all cases.

It is therefore suggested that the Folin-phenol reagent method holds good with leaf proteins and may be employed with advantage wherever similar studies are to be made.

(This work was done at the Utah State University, Logan : USA.)

Agricultural College, Dharwar, *September* 18, 1960. N. G. PERUR.

1. Lowry, O H., Rosebrough Nira j. Farr A. L. and Randall, Rose, J., "Protein measurement with Folin-phenol reagent," *Jour. Biol. Chem.*, 1951, **193**, 264.

A HÆMAGGLUTINATING STRAIN OF *MIYAGAWANELLA* CAUSING POLYARTHRITIS IN SHEEP IN INDIA

AN apparently new disease entity polyarthritis in sheep was encountered accidentally in two out of a batch of 20 lambs, 4 to 6 months in age, purchased for experimental induction of virus pneumonia and kept under observation prior to artificial infection. The affected lambs showed involvement of joints and pyrexia (104-06° F.) that persisted for 4 to 6 days before manifestation of panarthritis and consequent lameness.

All the joints were swollen and acutely painful as the lambs resisted any physical manipulation. They became recumbent on the 4th day and both of them succumbed to the infection on the 7th day. Peripheral blood smears at the height of pyrexia showed no protozoa of pathogenic significance, while bacteriological examination of the joint fluids, heart blood and other tissues on blood agar and in serum broth yielded no micro-organism of ætiological importance. All attempts were made to isolate well-known microbial pathogens of arthritis like *Corynebacterium pyogenes*, *C. pseudotuberculosis*, *Erysipelothrix insidiosa*, and *Mycoplasma agalactiæ* with entirely negative results.

A virus-like agent was recovered from the aspirated specimens of synovial fluids from the knee and hock joints of both the affected lambs through intraperitoneal inoculation into guinea-pigs. Macchiavello- and Giemsa-stained impression smears of synovial fluid and scrape-smears of joint cavities showed typical intracytoplasmic inclusion bodies (Fig. 1).

On autopsy, all the internal organs showed generalised congestion but, otherwise, appeared normal. No virus could be recovered from pooled suspensions of liver, spleen, kidney, lungs and brain while prescapular and precrural lymph nodes, which were enlarged and hyperæmic, yielded the agent on intraperitoneal inoculation into guinea-pigs.

The virus, so isolated, has since been maintained by serial passages in guinea-pigs,

wherein it has undergone, so far, three sub-inoculations. The causal agent was found to belong to the Psittacosis-lymphogranuloma venereum group of viruses inasmuch as it (*i*) formed elementary bodies; (*ii*) was relatively sensitive to oxytetracycline and penicillin but not to streptomycin; (*iii*) was pathogenic for 7 to 8-day-old embryonating hen's eggs when inoculated *via* the yolk-sac route killing them between 7th and 9th day; (*iv*) produced characteristic pathological changes, like sterile fibrinous peritonitis and splenomegaly, in adult guinea-pigs when they were destroyed on the 10th day following inoculation; and (*v*) showed cross-reaction to a titre of 1 : 32 to 1 : 64 in the complement-fixation test with the antisera against the Nagano strain of goat pneumonitis[1] and Shizuoka strain of bovine encephalomyelitis,[2] gifts of which were generously made to us by Dr. Susumu Ishii, Director, National Institute of Animal Health, Tokyo, Japan. It was found that sheep arthritis virus, at dilutions comparable with those of the other two suspensions,[1,2] gave a full degree of fixation in the presence of both sera. Further tests showed that antibody reacting with all three virus preparations could be removed completely from both sera by absorption with a heated suspension of the new virus.

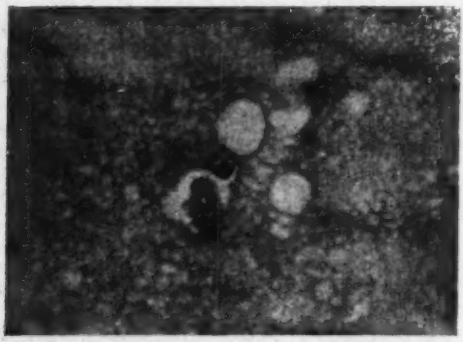


FIG. 1. Scrape-smear from the lining of joint cavity of an affected lamb showing intracytoplasmic inclusion body. (Macchiavello, × 1,000.)

However, some differences were observed notably the refractoriness of mice to experimental infection by intraperitoneal, intracerebral and intranasal routes and susceptibility of the complement-fixing antigen prepared from this strain towards phenol[3] and urea.[4]

The polyarthritis virus, when propagated in the allaantoic cavity of 8-day-old embryonating eggs, proved capable of hæmagglutinating mouse erythrocytes, which property had till now been found to be associated only with *Miyagawanella* strains of avian origin.[5,6] The virus had no action on the erythrocytes of any of many other species tested, *viz.*, rabbit, guinea-pig, pigeon, chick, horse, cattle, buffalo, sheep and goat. The hæmagglutination-inhibition (HI) and complement-fixation (C.F.) tests provided reliable methods for measuring antibody in the two naturally infected lambs before their death. Their sera collected on the 6th day gave titres of 1 : 256 to 1 : 512 in the HI and 1 : 64 to 1 : 128 in the C.F. tests against an antigen prepared from the homologous arthritis virus. The two samples of serum from infected lambs were found to fix complement to a similar extent with heated preparations of goat pneumonitis[1] and bovine encephalomyelitis[2] viruses, as in each case a serum titre of 1 : 64 was recorded. None of the other fifty healthy sheep (including 16 lambs from the same group) that were examined showed antibodies reactive in the above tests in their sera at levels of above 1 : 8.

Thus, the heat-stable antigen common to Psittacosis-lymphogranuloma group of viruses was readily demonstrated in the virus of polyarthritis of sheep, which should therefore be classified with this group.

Mice that received infective material from naturally affected lambs were found to be entirely hale and healthy after three weeks but, when their sera were collected on the 22nd day following infection and tested, they showed HI titres of 1 : 256 to 1 : 512 and C.F. values of 1 : 64 to 1 : 128 against the homologous virus antigen. Thus, it seemed justifiable to conclude that the mice suffered from an asymptomatic benign immunising infection with this virus strain.

As far as the authors are aware, this seemed to be the first report of its kind, as they were unable to trace any previous reference to isolation of a virus from cases of arthritis in sheep either in India or other countries.

Division of Pathology and Bacteriology, Indian Veterinary Res. Ins., Mukteswar-Kumaon.
P. G. PANDE.
R. R. SHUKLA.
P. C. SEKARIAH.

August 26, 1960.

1. Omori, T., Ishii, S., Harada, K., Ichikawa, O., Murase, N., Katada, M. and Araumi, W., *Exp. Rep. Govt. Exp. Stat. Anim. Hyg.*, Tokyo, 1953, No. 27, 109.
2. 〃, Kawakami, Y., Ishii, S., Ishitani, R., Harada, K. and Matumoto, M., *Jap. J. Exp. Med.*, 1954, 24, 257.

3. Nigg, C., *Science*, 1942, **95**, 49.
4. —, Hilleman, M. R. and Bowser, B. M., *J. Immunol.*, 1946, **5**, 201, 259, 269.
5. Inaba, Y., Omori, T., Ishii, S. and Matumoto, M., *Jap. J. Exp. Med.*, 1957, **27**, 425.
6. Pande, P. G., Shukla, R. R. and Sekariah, P. C., *J. Infect. Dis.*, 1960 (In Press).

ON THE OCCURRENCE OF PELAGIC FISH SPAWN

It is well known that the spawn of marine fishes usually occurs as individual eggs in the plankton and it is very rare to find large numbers of eggs collected together in a single mass. During the past ten years we have come across only three such spawns all of them similar and apparently belonging to the same species of fish. There are only two previous reported instances of such spawns from Indian waters. Nair (1952) described a metre long ribbon-shaped spawn from the plankton collected off Madras but he was not able to establish its identity. Padmanabhan (1957) described hollow tubular egg masses measuring 18" to 20" of *Antennarius marmoratus* from the laboratory tanks at Trivandrum. The only other account of a fish spawn mass is that of *Lophius piscatorius* described by Ehrenbaum (1905) from the North Sea which consisted of a number of eggs, each egg being enclosed in a capsule.

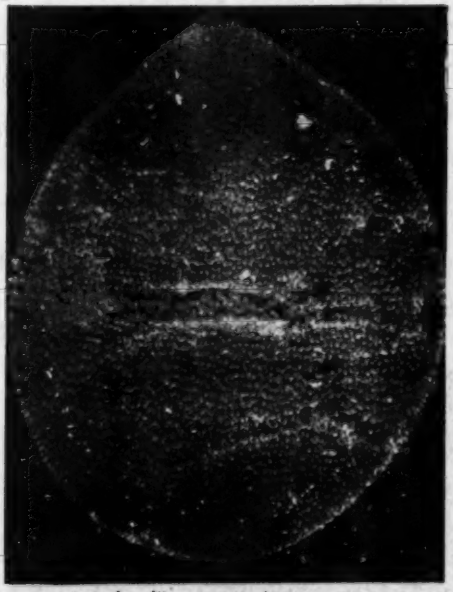


FIG. 1. Photograph of spawn mass

The three spawn masses described here were obtained from the surface plankton during the months of September and December 1958 and January 1959. These are different from those described by Nair and Padmanabhan. The spawn mass (Fig. 1) was in the form of a hollow oval rubber balloon, measuring 6½ cm. in length and 4 cm. in breadth. There were nearly 2,000 eggs, each egg being enclosed in a separate capsule. The eggs (Fig. 2) were more or less

FIG. 2. Part of the spawn magnified.

oval in shape, measuring 1·6 mm. in length and 1·08 mm. in breadth. The yolk is unsegmented and an oil globule is absent. The eggs were in different stages of development. The spawn mass collected on 10th December 1958 was kept in clean sea-water and the larvæ hatched out the next day. Most of the larvæ survived for about four days after which they rapidly dwindled and only two survived for seven days.

The identity of the spawn mass could not be established as the hatchlings did not survive long enough to establish the larval characters necessary for identification. The paucity of adequate literature on such spawn masses also rendered it difficult to establish the identity of the spawn. It is, however, hoped that we may succeed in rearing the larvæ successfully to an advanced stage and establish their identity if such spawn masses are again encountered at a future date.

Dept. of Zoology, P. N. Ganapati.
Andhra University, N. Solomon Raju.
Waltair, *November* 8, 1960.

1. Ehrenbaum, E., *Eier. Und. Larven. Von Fischen Nordisches plankton*. 1905, 146.
2. Nair, R. V., *Proc. Ind. Acad. Sci.*, 1952. 35 (5) B, 181.
3. Padmanabhan, K. G., *Bull. Central Res. Instt., Travancore University*, Trivandrum, 1957. 5 (1).

GERMINATION OF GRAPE (*VITIS VINIFERA* L.) HYBRID SEEDS BY CHILLING

In grape-breeding considerable difficulty was experienced in the germination of hybrid seeds during 1959. An attempt to break the dormancy of the seeds of grape crosses was made at Hyderabad[1] by subjecting them to cold treatment at 0° C. in a refrigerator for one month prior to sowing but only 4·6 and 5·8% germination could be obtained in 1952-53 and 1953-54, respectively. Flemion,[2] and Scott and Ink[3] have reported that an after-ripening period of three months at a cold temperature (5° C.) is essential for the optimum germination of grape seeds. A preliminary experiment was, therefore, laid out at the Horticultural Research Institute, Saharanpur, for the germination of grape crosses by seed-chilling.

The hybrid seeds of fourteen grape crosses were fully dried after extraction. Seeds of each cross were divided in three portions and kept in stoppered glass phials. The three lots were stored at the room temperature (70°–80° F.) and in the cold storage at 40° F. and 35° F. respectively. After three months, the seeds were taken out and sown in earthen pans.

The germination of the seeds of each lot was recorded separately at weekly intervals from December 1959 to April 1960. The number of seeds sown, germinated and percentage of germination is given in Table I.

It is evident from Table I that most of the hybrid seeds stored at the room temperature (70°–98° F.) did not germinate at all. On an average the grape seeds chilled at 40° F. showed a higher germination percentage than the seeds stored at 35° F.

Thus, a satisfactory germination of grape seeds can be obtained by chilling them at 40° F. for a period of three months and thereby, a larger hybrid population can be raised in hybridization programmes.

TABLE I

Germination of grape hybrid seeds three months after storage

Sl. No.	Hybrid seeds of the cross	Seeds chilled at 35° F. for 3 months			Seeds chilled at 40° F. for 3 months			Seeds stored for 3 months at room temp (70°–80° F.)		
		No. of seeds sown	No. germinated	% germination	No. of seeds sown	No. germinated	% germination	No. of seeds sown	No. germinated	% germination
1	Saharanpur No. 2 × Dehradun	55	22	40·0	70	20	28·6	63	..	..
2	,, × Pearl of Csaba	50	33	66·0	50	29	58·0	29	..	..
3	,, × Motia ..	300	161	48·8	350	184	52·6	246	4	1·62
4	,, × Rose of Pen ..	50	15	30·0	50	31	62·0	13	..	..
5	,, × Muscat White	60	30	50·0	60	36	60·0	64	21	32·81
6	,, × Black Round	150	56	37·3	150	82	54·6	100	9	9·0
7	Motia × Saharanpur No. 2	25	7	28·0	25	14	56·0	11	..	..
8	,, × Pearl of Csaba	50	8	16·0	50	8	16·0	18	..	..
9	,, × Rose of Pen ..	40	27	67·5	40	10	25·0	24	..	..
10	,, × Black Round	100	53	53·0	100	35	35·0	39	..	..
11	Muscat White × Saharanpur No. 2	40	5	12·5	40	11	27·5	24	..	..
12	,, × Motia ..	50	18	36·0	50	30	60·0	50	..	..
13	Rose of Pen × Saharanpur No. 2	40	13	32·5	45	10	22·2	62	..	..
14	Black Round × Saharanpur No. 2	50	12	24·0	50	4	8·0	36	..	..
	Mean germination percentage	..	..	38·7 ±9·7	..	..	40·4 ±11·0	..	..	3·10 +5·12

Horticultural Research Inst., Saharanpur, *September* 5, 1960. S. N. SINGH.

1. Anonymous, *Final Consolidated Rep. Hyderabad Fr. Scheme*, 1941–57.
2. Flemion, F., *Contr. Boyce Thompson Inst.*, 1937, **9**, 7.
3. Scott, D. H. and Ink, D. P., *Proc. Amer. Soc. hort. Sci.*, 1950, **56**, 134.

AN APETALOUS MUTATION IN TORA BROWN SARSON (*BRASSICA CAMPESTRIS* VAR. *BROWN SARSON*) AND ITS INHERITANCE

A MUTANT in which the whorl of petals was missing was isolated by the author in his breeding material of *tora brown sarson* (self-fertile) at the Government Research Farm, Kanpur, in

1957-58. Earlier Ramanujam (1940) had reported an apetalous mutant in turnip.

Description of Mutant

The brown sarson apetalous mutant was like the apetalous mutant of turnip with regards to apetaly but differed from the latter in other floral characters. Instead of the usual 6 tetradynamous stamens characteristic of the cruciferæ family, the mutant had only 4 stamens in about 80% flowers on a plant. Of the remaining 20% flowers some had five and others six stamens but instead of the usual 4 long and 2 short stamens all the stamens were nearly of the same length or the 5th and 6th stamens were only very slightly smaller than the 4 long stamens. In these flowers which had only 4 stamens, either 2 stamens appeared to be completely missing or 2 stamens out of 4 were double due to their fusion with their neighbouring stamens. In some cases only the filaments were joined together. In others the anthers were also fused either only at the base or nearly up to the tip of the anthers. The pod and seed-setting were quite normal in the mutant.

Inheritance

In order to study the inheritance of the apetalous mutant, it was crossed with a normal variety. The F_1 was grown in 1957-58 at the PIRRCOM Centre, Kanpur. Normal was found to be dominant over apetalous in F_1.

The F_2 population segregated into 275 normal and 77 apetalous plants. This gives a good fit to 3 : 1 ratio as the chi-square value is not significant. (Chi-square 1·433 P. between 0·30 and 0·2.) The floral character of the mutant with regards to the morphology of the stamens was, however, found to be completely associated with apetalous condition. In F_2 all the plants with normal petals possessed the usual six tetradynamous stamens while the apetalous plants had stamens like the original apetalous mutant. It appears that apetaly and reduction in number of stamens is due to the pleiotropic effect of the same gene which causes complete loss of petals as well as reduction in the number of stamens.

Regional Research Centre, Dharampal Singh.
(Oilseeds and Millets), I.C.A.R.,
PIRRCOM, Kanpur, *September* 12, 1960.

1. Ramanujam, S. "An apetalous mutation in turnip (*Brassica campestris*)," *Nature*, **1940, 145, 552.**

FORMATION OF RED ROT ACERVULI ON THE NODES AND WITHIN THE TISSUES OF DISEASED CANES

The acervuli of red rot fungus appear as dark and minute dots on the straw-coloured central region of the lesions on the upper surface of the midribs of cane leaves. They are also formed on the rind of shrivelled and dried-up canes affected with red rot.[1,2]

In varietal susceptibility trials carried out at this Institute against *Colletotrichum falcatum* Went, strain 'D', two hitherto unreported observations were made. One was the development of acervuli on the root-primordia of inoculated canes, and the other, the production of pink spore masses of red rot fungus within the diseased stalks.

The acervuli were observed on 13 varieties, *viz.*, Co. 951, Co. 963, Co. 971, Co. 997, Co. 1055, Co. 1063, Co. 1073, Co. 1161, Co. 1184, Co. 1218, Co. 1235, Co. 1302 and Co.S. 510, out of 224 under trial. These were produced well before the inoculated cane stalks dried up and shrivelled. The soft black masses of acervuli were confined almost entirely to the primordia of roots, giving the impression that the root primordia themselves had been transformed into acervuli (Fig. 1). All the root primordia on

Fig. 1. Node of Co. 963 showing acervuli over root primordia.

a root band did not bear acervuli. Some of the primordia were unaffected. In varieties Co. 963 and Co. 997 the acervuli on the root primordia were covered with pink spore masses. It is likely that in other varieties also, pink spore masses appear during early stages.

Bits of these acervuli were transferred to oat meal agar medium ; they produced typical cultures of strain 'D' of *C. falcatum*.

The acervuli on the midrib lesions and rind of dried-up diseased canes have not been observed to be covered with pink masses of conidia. Moreover, these acervuli are small while those observed on root primordia are much larger and may be releasing a greater number of spores. Should these be produced in nature, the acervuli of root primordia may be a far more potent source of dissemination of red rot than those on the rind and midrib lesions.

Regarding the production of fungus spores within the canes, it is thought likely that spores are formed only after the cane stalks are altogether dried up and almost completely hollow. In our trials of 1959-60, acervuli with pink masses of conidia were found inside the stalks of inoculated canes of 13 varieties, *viz.*, Co. 947, Co. 963, Co. 997, Co. 1006, Co. 1024, Co. 1029, Co. 1033, Co. 1079, Co. 1142, Co. 1223, Co. 1235, G. 9195 and G. 9719. The reddening of the tissues was confined to a narrow central core, excepting in Co. 997 and Co. 1235 in which the entire cross-section was reddened. None of the canes however, dried up or was shrivelled. It therefore appears possible that fungus spores produced at such an early stage may get carried along with vascular passages to the extent of continuity of the latter and thus be responsible for quicker spread of infection.[2,3]

We are grateful to Sri. R. R. Panje, Director, Indian Institute of Sugarcane Research, Lucknow, for valuable suggestions.

Indian Institute of Sugarcane Research, Lucknow, *October* 3, 1960.

V. B. SINGH.
KISHAN SINGH.

1. Abbot, E. V., *U.S.D.A. Tech. Bull.*, 1938, 651.
2. Atkinson, R. E., *Int. Soc. Sugarcane Tech. Proc., 6th Conf.*, 1939, 684–92.
3. Tiwari, M. M., *Thesis for Assoc. I.A.R.I.* (Unpublished), 1957.

TWO FUNGI CAUSING SPOILAGE OF REFRIGERATED POULTRY MEAT

RECENTLY we received samples of fungal infested poultry meat from the Principal of the Veterinary College, Madras. These samples were taken from spoiled meat pieces stored under refrigeration at 5° C. for over 14 days. They were found affected by two types of fungi. One was characterized with specks of raised cottony white growth on the surface, while the other was dull-brown in colour, with long threads of mycelium spreading sparsely over the meat. Both the organisms were isolated, brought into pure culture and their characters studied.

The two fungi could grow well on liver extract and yeast extract agar media and moderately well on potato dextrose agar.

The growth at room temperature (28-30° C.) was very meagre and slow, but when the cultures were incubated at 5-8° C. profuse growth was obtained in both cases.

The white fungus gives cottony aerial mycelium on the agar slants. On microscopic examination, the hyphæ are found hyaline, thin-walled, narrowly septate, with numerous fat-like globules, and 2·8 to 3·5 μ in thickness. Conidia are borne singly on conidiophores which are either terminal or formed on short, slender branches. Only macroconidia are observed. They are fusiform, hyaline, thin-walled, crenulate, 1 to 5 septate, mostly 3 septate, and measure 8·0–14·0 $\times$ 3·0–4·1 μ. Based on these characters the fungus is identified as *Microsporum* sp.[1]

The second fungus grows mostly submerged in the agar media, but with a few silky dull-brown aerial hyphæ sparsely spreading on the surface. It does not produce any soluble pigment in any of the media tested. On microscopic examination the hyphæ are found hyaline, 2·8 to 3·5 μ thick, and broadly septate. Numerous conidiophores are found which are stout, simple or branched, septate with inflated columella-like structures which are either terminal or intercalary. These structures measure 25 to 40 μ in diameter, are thin-walled and hyaline and bear the head of conidia acropetally on their surface. The conidia are ovoid to ellipsoid, thin-walled, smooth, light-brown in colour and measure 3·6–6·2 $\times$ 2·4–4·7 μ. The fungus is identified as a species of *Gonatorrhodiella*.[1]

To examine the harmful effect of the fungi on meat, slices of fresh chicken and lamb meats were prepared, washed well in sterile water, placed in boiling tubes, plugged with cotton wool and steamed for 30 minutes in an autoclave. Pure cultures of the fungi were inoculated into the tubes and incubated at 5–8° C. in a refrigerator and also at room temperature. There was very little or no growth of the two fungi at room temperature, but at 5–8° C. there was fluffy-white growth of *Microsporum* sp., and silky-brown growth of *Gonatorrhodiella* sp., covering completely the meat pieces (Fig. 1). When the meat pieces were examined after seven days' incubation, characteristic musty odour was noted in the inoculated tubes; the meat pieces were discoloured dull-brown and considerably softened, as against little or no change in the uninoculated pieces. In the case

of meat piece inoculated with *Microsporum* sp., besides softening of the tissues, dark-brown liquid collected at the bottom of the tubes, but not with *Gonatorrhodiella* sp.

FIGS. 1–3. Fig. 1. Uninoculated chicken meat. Fig. 2. Chicken meat inoculated with *Gonatorrhodiella* sp. Fig. 3. Chicken meat inoculated with *Microsporum* sp.

Of the two genera, species of *Microsporum* are known to be parasitic to man and animal, causing dermatomycoses.[2] The species under study probably had its origin from the poultry birds. *Gonatorrhodiella* sp., however, seem to have not been so far reported on poultry meat or any other animal substrata. These studies indicate the need for careful examination of the meat before and after storage at low temperatures under Indian conditions so as to avoid the danger of preserving and spreading the harmful micro-organisms.

Dept. of Agriculture, Annamalai University, Annamalainagar (S. India), *September* 2, 1960.

G. RANGASWAMI.
R. VENKATESAN.

1. Parnett, H. L., *Illustrated Genera of Imperfect Fungi*, Burgess Publishing Co., Minneapolis, Minn., U.S.A., 1955.
2. Conant, N. F., Martin, D. S., Smith, D. T., Baker, R. D. and Colloway, J. L., *Manual of Clinical Mycology*, W. B, Saunders Co., Philadelphia, U.S.A., 1944.

BLIGHT OF FENNEL IN RAJASTHAN

I. Morphology and Identity of the Pathogen

FENNEL (*Fœniculum vulgare* L.), an important cash crop in Ajmer and Kota Divisions of the State, has been found to suffer severely from a blight disease. The disease first appears in January on lower and older leaves of the plant as minute, angular, brown necrotic areas which later become larger and are covered with greyish-white erumpent growth (Fig. 1). The disease advances upwards and the linear and rectangular spots coalesce covering the entire stem, peduncles and fruits. Severely affected leaves shrivel and dry up. In plants affected in early stages, seed formation does not take place and in others seeds are shrivelled and blackened.

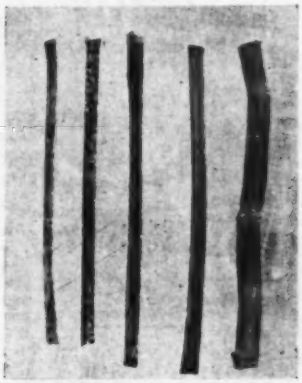


FIG. 1. A—healthy stem; B—Diseased stem of Fennel.

A popular account of the disease, attributed to *Cercospora fœniculi* Magn. was given in 1950 from Ajmer[1] and later Joshi[5] studied its symptoms, morphology and phenological relations. Sydow and Mc Rae[7] believed *C. fœniculi* (first recorded from India by them from Harwan, Kashmir and Pusa, Bihar), to be merely a form of *Fusicladium depressum* (Berk. and Curt.) Sacc. Chupp[3] could not find any resemblance of this *Cercospora* species with the characters generally attributed to *Fusicladium* and is of the opinion that *Ramularia fœniculi* described by Sibilia[6] should also be classed as a species of 1-septate *Cercospora* better disposed off as *Didymaria*. Since the systematic position of the pathogen was uncertain, and since in recent years the disease assumed epiphytotic form throughout the fennel-growing tract of the State (Ajmer, Kekri, Deoli, Malpura and Tonk), studies were undertaken by the authors.

The usual method of isolation, namely, plating the surface sterilized diseased bits of the plants, did not yield the fungus in culture. However, the conidia of the fungus readily germinated in water (Fig. 2, *b*) within 24 hours. To obtain the culture, single germinating conidium was

further transferred to P.D.A. 2%; P.D.A. 5%; fennel leaf extract added to P.D.A.; fruit extract and dextrose agar; carrot extract agar; Czepek's agar and Richard's agar media with and without yeast; Czepek's and Richard's media with and without yeast; sterilized stem of fennel; Agar 1·5% + Extract of fruits and leaves of fennel 20% + water; Agar 1·5% + Carrot decoction 15% + water and Agar 1·5% + Maltose 2% + Ammonium phosphate 0·5% + water. The fungus defied all attempts to bring it into culture on artificial media.

The morphological characters and size of the conidiophores and the conidia of the fungus and those of *F. depressum*, *C. fœniculi* and *R. fœniculi* reported by earlier workers have been compared in Table I. The authors agree with Chupp[3] who ruled out the possibility of the causal organism being *Fusicladium depressum* which invariably has 1-celled, dark conidia. The fungus under study does not agree with the characters of *Didymaria* which has non-catenate conidia. It can best be accommodated in the genus *Ramularia* differing from *Cercospora* in the absence of long filiform or vermicular 3 or more celled conidia. The symptoms and general morphological characters of the pathogen, i.e., fuligenous and fasciculate conidiophores, bearing at their more or less converged extremity, 1-septate cylindrical catenate conidia with obtuse ends, compare favourably with *R. fœniculi* Sibilia, although it physiologically differs from the one studied by Sibilia[6] in its behaviour towards growth in artificial media. Further work is in progress.

TABLE I

Comparison of the size and characters of conidiophores and conidia of the fungi causing blight diseases of Fœniculum vulgare

Sl. No.	Pathogen	Characters of the conidiophores	Characters of the conidia	No of septa	Authority
1	*Fusicladium depressum*	6-7 $\mu \times 50$-60 μ (100-120 μ on old fructifications)	6-7 $\mu \times 40$-45 μ hyaline, irregular and constricted at middle	1	Barthelet and Vinat[2]
2	*Cercospora fœniculi*	4·5-7 $\mu \times 10$-40 μ geniculate, undulate and curved	4-6·5 $\mu \times 15$-75 μ sub-hyaline	1-5	Chupp[3]
3	*Ramularia fœniculi*	6·5 $\mu \times 47$-55 μ fuligenous bearing conidia at extremity	6·5 $\mu \times 45$·5 μ hyaline catenate, elongated or cylindrical	1	Sibilia[6]
4	Fungus under study	6·4 $\mu \times 42$·8-56·4 μ sub-hyaline, bearing codidia at the tip	6·4 $\mu \times 19$·2-44·8 μ hyaline, catenate (2-3) cylindrical	1	Authors

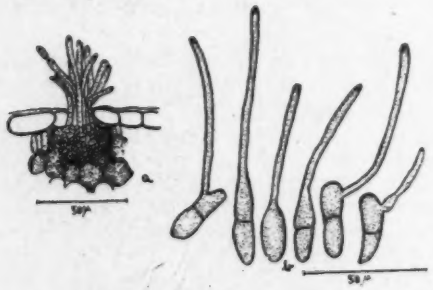


FIG. 2. *R. fœniculi*. (*a*) Conidiophores; (*b*) Germinating conidia.

The pathogenicity was tested by placing drops of sterile water containing conidia of the pathogen directly removed from the diseased stems. Typical symptoms of the disease appeared in 10-11 days on leaves, petioles, stems and pedicels of the inoculated plants only. The fungus produced was identical with the original one and possessed hyphæ hyaline and intercellular; conidiophores fasciculate arising from the stroma, sub-hyaline measuring 6·4 $\mu \times$ 42·8-56·4 μ (Fig. 2, *a*); and conidia catenulate (2-3) hyaline with mostly 1 septum, invariably cylindric, measuring 6·4 $\mu \times$ 19·2-44·8 μ,

Sincere thanks are due to Shri Samrath Raj Director of Agriculture, Rajasthan, for facilities.

Plant Pathology Section, Department of Agriculture, Rajasthan, Udaipur, *September* 26, 1960.

N. PRASAD.*
R. L. MATHUR.
J. P. AGNIHOTRI.

1. Anonymous, *Plant Prot. Bull.*, 1950, **1**, 28.
2. **Barthelet, J. and Vinat, M., *Ann. Epiphyt.* 1944, N. S., 10, Fasc. Unique, 11.
3. Chupp, C., *A Monograph of the Fungus Genus* Cercospora, Ithaca, New York, 1953.
4. Clements, F. C. and Shear, C. L., *The Genera of Fungi*, Hafner Publishing Co., New York, 1957.
5. Joshi, N. C., *Agra Univ. Jour. Res.*, 1957, **6**, 89.
6. Sibilia, C., *Bull. R. Staz. Pat. Veg.*, 12, N. S., 1932, **2**, 210.
7. Sydow, H. and Mc Rae, W., *Ann. Cryptg. Exot.*, 1929, **2**, 262.

* Now Principal, S. K. N. Govt. College of Agriculture, Johner.

** Original not seen.

HEYLANDIA LATEBROSA DC.—A PROMISING LEGUME

In the hilly grasslands of Raita near Bombay *Heylandia latebrosa* (Vern.—*Godhadi*) is a very common legume, found growing in association with tall grasses, *Themeda triandra* Forsk., *Pseudanthistiria heteroclita* Hook. f. and *Ischæmum aristatum* Linn. During the manurial studies of grasslands, it was observed by the authors that this legume established itself well and grew luxuriantly when protected from over-grazing. It checked the growth of weeds and was relished by the cattle in that area. Its flowers are sweetish and are believed to be used as pot-herb. Burns *et al.* (1916) had reported that this legume can form a thick carpet in grasslands. Whyte (1957) reported that yield trials of *Heylandia latebrosa* conducted over two seasons at Dharwar in Mysore State gave good response. Under the present system of harvesting at Raita, which is in the middle of October, *Heylandia* will have dried up and its proportion in the herbage is very small since the grasses whose grand period of growth lies between September and October arrest its growth by overshading it. In the middle of September, however, it is luxuriant and constitutes a substantial part of the herbage. Analysis of this legume at the flowering stage (oven-dry basis) showed: crude proteins, 8·968; ash, 6·926; insoluble ash, 0·754; Ca, 1·005; P_2O_5, 0·138; crude fats, 4·937; and crude fibres, 26·0%.

Chemical analysis of the legume at flowering stage shows that it is rich in crude protein, crude fats, and soluble ash in comparison with the grasses. Its fibre content is also less and the calcium content is good. It can, therefore, contribute to the nutritional qualities of the herbage.

Botany Department, J. V. Shankar.*
The Institute of Science, F. R. Bharucha.**
Bombay, *October* 28, 1960.

Present Address:

* Council of Scientific and Industrial Research, New Delhi.

** College of Agriculture, Abu Ghraib, Iraq.

1. Burns, W., Bhide, R. K., Kulkarni, L. B. and Hanmante, N. M., "*Heylandia latebrosa* DC.," *Bull. Lep. Agric.*, Bombay, 1916, No. 78.
2. Whyte R. O. *The Grassland and Fodder Resources of India.* The Indian Council of Agricultural Research, New Delhi, 1957, 304.

MORPHOLOGY, CYTOLOGY AND BREEDING BEHAVIOUR OF HYBRIDS BETWEEN *CORCHORUS OLITORIUS* AND *C. CAPSULARIS*

Attempts have been made without success since the early years of this century to produce hybrids between the two cultivated species of jute, *Corchorus olitorius* L. and *C. capsularis* L. with a view to combine the several desirable features which each of these species possesses.[1] Ganesan *et al.*[2] were the first to show that the failure of seed-setting in this cross is not due to lack of fertilization but is caused by the premature abortion of hybrid embryos. They also recorded the occurrence of occasional heart-shaped embryos and suggested that by culturing these embryos in suitable media, hybrid seedlings could be raised. Sulbha and Swaminathan[3] subsequently confirmed the findings of Ganesan *et al.*,[2] and recommended the use of reciprocal grafting, pollen irradiation and hormone application to overcome the incompatibility barrier in this cross. Encouraged by the findings of Ganesan *et al.*,[2] Islam and Rashid[4] attempted the cross *C. olitorius* × *C. capsularis*, using 300 p.p.m. 3-indole-acetic-acid to smear the pedicel following pollination. During 1959, they found three hybrid plants among the material obtained in this way and published a brief account of the morphological characteristics and meiotic behaviour of these hybrids early in 1960.[4]

In May 1959, we observed a plant among the seedlings raised from a cross made in 1958 between *C. olitorius* var. Chinsurah green (♀) and *C. capsularis* var. JRC 13 grafted on *C. olitorius* (var. Chinsurah green) rootstock (♂), which had a weak and unbranched stem and leaves resembling closely the *capsularis* parent. This plant flowered earlier than the female parent but later than male and produced a few, mostly solitary, flowers. The capsules were strikingly intermediate in shape and size, with irregular projections and depressions running along the ribs (Fig. 1). These features suggested that this plant may be a real hybrid between *olitorius* and *capsularis*.

Meiosis was studied in the microsporocytes of this plant and in 7 out of the 15 cells examined at Metaphase I, one quadrivalent or one trivalent and a univalent were present (Fig. 2). Six bivalents and two univalents were seen in 5 cells. The mean frequency per cell of the different types of associations was: $0·2_{IV} + 0·27_{III} + 5·47_{II} + 1·47_{I}$. Pollen fertility as estimated by stainability in acetocarmine was 60%. The average number of seeds per capsule

was 74·8 in the F_1 in contrast to 204·3 and 41·7 found in *C. olitorius* and *C. capsularis* respectively. The colour of the seed-coat was steel-gray in the hybrid as compared to green in the female parent and brown in the male parent. The seeds were also intermediate in size.

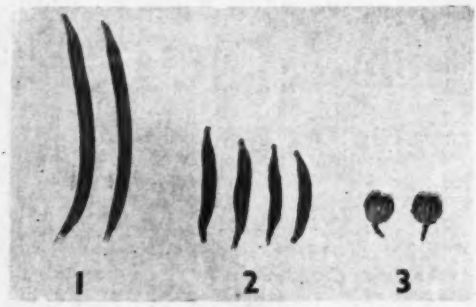


FIG. 1. Capsules of (1) *Corchorus olitorius*, (2) F_1 hybrid and (3) *C. capsularis*.

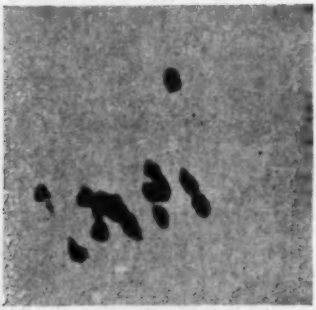


FIG. 2. Metaphase I in the F_1 plant showing $4_{II} + 1_{IV} + 2_I$ (one univalent is lying over a bivalent).

A study of the progeny of this plant raised during 1960 confirmed the hybrid nature of the parent. Thus, there was segregation in the F_2 population for (*a*) growth and vigour, (*b*) branching habit, (*c*) leaf length/breadth index and serration, (*d*) date of first flowering, (*e*) flower characters and (*f*) capsule size and shape. Also, the percentage of survival in the F_2 progeny was only 60 in contrast to the nearly complete survival found in the case of the two parents. While the detailed data will be reported elsewhere, it may be mentioned here that the germination, survival and segregation behaviour of the F_2 population conforms to the pattern reported in interspecific crosses in genera where cryptic structural differentiation of chromosomes has played an important part in speciation.[5]

During 1960, one more hybrid plant was obtained from a cross between *C. olitorius* var. IC 325 grafted on *C. capsularis* var. JRC 212 rootstock and *C. capsularis* var. IC 330 (pollen irradiated with 2,000 *r* of X-rays). This hybrid resembled closely the one isolated during 1959 and was also characterised by the presence of one quadrivalent in the microsporocytes. Thus, though different varieties of *olitorius* and *capsularis* had been involved in the parentage of these two hybrids, both showed heterozygosity for a reciprocal translocation. Islam and Rashid[4] have, however, recorded regular bivalent formation in the hybrid plants studied by them. The interchange observed in our 1960 hybrid could also have been induced by the radiation treatment, though pollen transmission of such aberrations is rare. Thus, the reciprocal translocation recorded in our material may not *per se* be a species differentiating factor. From the occurrence of unthrifty seedlings and block transference of certain parental characters in the F_2 population, cryptic structural differentiation appears to have been an important mechanism controlling the divergence of these two cultivated species. Only further studies would show whether this would impose any limitation on the breeding possibilities of this material. The successful hybridizaton of these two species, after several decades of unsuccessful attempts, is, however, a significant achievement and may well prove to be an important milestone in the history of jute breeding in India.

We are indebted to Dr. B. P. Pal, Director, and Dr. A. B. Joshi, Head of the Division of Botany, for their advice and encouragement. We are also grateful to Dr. S. M. Sikka, Additional Agricultural Commissioner with the Government of India, for his interest in this study. Finally, our sincere thanks are due to Messrs. N. Gupta, H. C. Bansal and R. P. Puri for assistance in crossing work.

Indian Agri. Res. Inst., New Delhi,
October 22, 1960.

M. S. SWAMINATHAN.
R. D. IYER.
K. SULBHA.

1. Kundu, B. C., *Jute in India*, Published by the Indian Central Jute Committee, Section I. *Agriculture*, 1959, p. 41.
2. Ganesan, A. T., Shah, S. S. and Swaminathan, M. S., *Curr. Sci.*, 1957, 26, 292.
3. Sulbha, K. and Swaminathan, M. S., *Ibid.*, 1959, 28, 460.
4. Islam, A. S. and Rashid, A., *Nature*, 1960, 185, 258.
5. Stebbins, G. L., *Variation and Evolution in Plants*, Columbia University Press, 1950, p. 643.

EPICOCCUM NIGRUM LINK. : A NEW REPORT FROM INDIAN SOILS

Epicoccum is a genus of Moniliales belonging to the family Tuberculariaceæ, reported as occurring in the soils of Canada.[1] Recently Ragab[2] has reported the genus from soils of Egypt. During the course of the study of the fungal flora of 'Usar' soils of Uttar Pradesh (R. N. Ghosh, unpublished), *Epicoccum nigrum* has been isolated from soil samples collected at Banthra Extension Nursery of the National Botanic Gardens, Lucknow. The fungus is isolated from soil samples collected during the rainy season (July to October) of 1959 at a depth of 6–18" from the surface. The soil is typically 'Usar' with an average pH range of 9·24 to 9·89 and an average moisture content of 2·35 to 6·99. Soil cultures were made by Waksman soil dilution plate method,[3] and maintained on synthetic nutrient agar slants. Sporodochia were produced in cultures maintained at room temperature in 4 to 6 days.

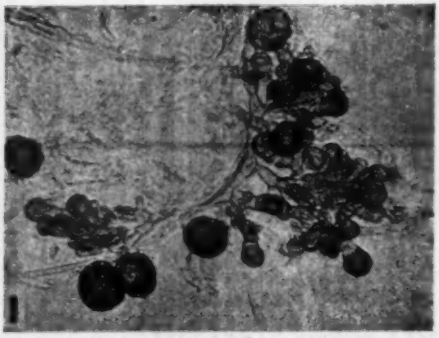


FIG. 1. Photomicrograph of *Epicoccum nigrum* Link, showing conidia and conidiophores.

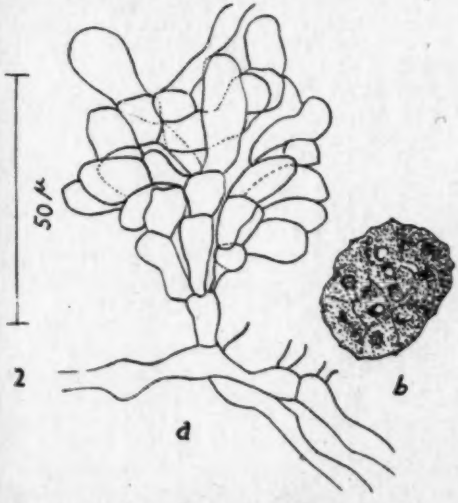


FIG. 2. (*a*) Conidiophores. (*b*) Single Conidium.

The stroma is black and the reverse of the colony is bluish-black in colour. The sporodochia are scattered and hemispherical. Conidiophores are club-shaped (Fig. 1), and black in colour. The size of the conidiophores ranges from $12·3 \times 5·0$ to $14·0 \times 7·0\,\mu$. The conidia are spherical, 21 to $25\,\mu$ occurring singly at the tip of the conidiophores, and brown to black in colour. The surface of the conidia possesses minute granulation (Fig. 2).

Epicoccum nigrum Link. has been isolated for the first time from Indian soils.

Thanks are due to Prof. K. N. Kaul, Director, for the help and encouragement during the study. Thanks are also due to the Head of Mycology and Plant Pathology Division, I.A.R.I., New Delhi, for the confirmation of the identification.

Fungi Section, R. N. GHOSH.
Botany Laboratory,
National Botanic Gardens,
Lucknow, *October* 5, 1960.

1. Bisby, G. R., Timonin, M. and James, N., *Canad. Jour. Res.* (Sec. C), 1935, 13, 47.
2. Ragab, M. A., *Mycologia*, 1956, 48, 167.
3. Waksman, S. A., *Principles of Soil Microbiology*, William & Wilkins Co., Baltimore, U.S.A., 1927.

MULTIPARASITISM BY *AHOLCUS EUPROCTISCIDIS* MANI AND *TRICHOGRAMMA EVANESCENS MINUTUM* RILEY IN THE EGGS OF *EUPROCTIS LUNATA* WALKER

Euproctis lunata Walker is a very serious pest of castor in the plains of India. Two species of parasites were observed to breed in the eggs of this pest. One was the scelionid, *Aholcus euproctiscidis* Mani, and the other the trichogrammatid, *Trichogramma evanescens minutum* Riley. Careful observations by the dissection of the eggs of *Euproctis* revealed the occurrence of multiparasitism. Very often multiparasitism results in the death of one or the other species and in the present case it was observed that invariably *Trichogramma* successfully completed development and emerged.

Experiment No. 3.—When these host eggs were dissected 5 hours after exposure to *Trichogramma*, dead first instar larvæ of *Aholcus* and *Trichogramma* eggs were observed.

Identical results were obtained when the host eggs were dissected one hour after exposure *Trichogramma*.

EXPERIMENTS AND OBSERVATIONS

TABLE I

Experiment No.	Condition of host eggs when exposed	Host eggs exposed to	Whether the parasite accepted them or not	Whether development of *Aholcus* takes place or not	Whether development of *Trichogramma* takes place or not
1	Just parasitised by *Trichogramma*	*Aholcus*	Yes	No	Yes
2	Just parasitised by *Aholcus*	*Trichogramma*	Yes	No	Yes
3	With 24-hour old larva of *Aholcus*	do.	Yes	No	Yes
4	With 30-hour old larva of *Aholcus*	do.	Yes	No	Yes

Experiment No. 4.—When host eggs containing 30-hour old larvæ of *Aholcus* were dissected 5 minutes after exposure to *Trichogramma*, live first instar larvæ of *Aholcus* and *Trichogramma* eggs were observed. Dissection 10 minutes after *Trichogramma* laid eggs, showed that the first instar larvæ of *Aholcus* were rather sluggish. Body movements were not noticed. Only the mandibles showed slight movement. In other words, they were in a moribund stage. All host eggs in which *Trichogramma* eggs were allowed to develop for more than 10 minutes showed only dead first instar larvæ of *Aholcus*.

It was further observed that when the host eggs were first attacked by *Trichogramma* and then by *Aholcus*, the number of *Trichogramma* emerged (from a single host egg) was more and the development was completed in a shorter period than when the host eggs were first attacked by Aholcus and then by *Trichogramma* (see Tables II and III).

TABLE II

Host eggs parasitised first by Trichogramma *and then by* Aholcus

Serial No. of host eggs	No. of *Trichogramma* emerged	No. of *Aholcus* emerged	No. of days taken for development and emergence at 75-80° F. and relative humidity 75%
1	5	0	11 days
2	6	0	
3	5	0	
4	5	0	
5	5	0	
6	6	0	

TABLE III

Host eggs parasitised first by Aholcus *and then by* Trichogramma

Serial No. of host eggs	No. of *Trichogramma* emerged	No. of *Aholcus* emerged	No. of days taken for development and emergence at 75- 0° F. and relative humidity 75%
1	2	0	15 days
2	2	0	
3	2	0	
4	2	0	16 days
5	2	0	
6	3	0	

It is rather interesting to note that the very presence of *Trichogramma* eggs is detrimental to the grubs of *Aholcus*.

Division of Entomology, Indian Agri. Res. Inst., New Delhi-12, *October* 17, 1960.

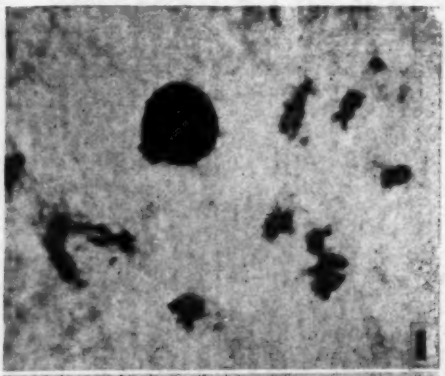
B. R. SUBBA RAO.
M. J. CHACKO.

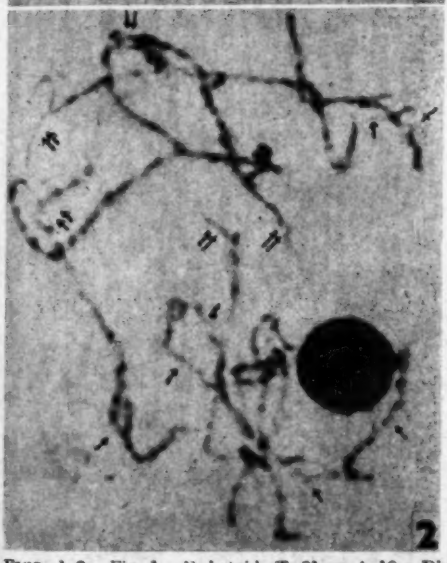
PACHYTENE ANALYSIS IN *JAPONICA-INDICA* RICE HYBRIDS

CYTOLOGICAL analyses of inter-sub-specific hybrids of *Oryza sativa* L. were undertaken by several workers,[3,4,6,8] all of whom emphasized the existence of chromosome structural hybridity. Oka[5] and his collaborators,[2] on the other hand, postulated that the sterility in these hybrids is due to the recombination between several pairs of duplicate genes. Since all the earlier investigators except one[8] confined their analysis to diakinesis and later stages of meiosis, the present study was undertaken to analyze these hybrids at diplotene and pachytene stages.

The most significant observation in the present study was of the occurrence of small translocations which were recorded as quadrivalents at diplotene (Fig. 1) in 1·5 to 10·3% of the cells. Their infrequent occurrence is probably due to the smallness of the interchanges and their sub-terminal location. Unlike in the inversion heterozygotes, where the occurrence of an anaphase bridge is a prerequisite for the reduction in fertility, the translocation heterozygotes might be of reduced fertility by the independent assortment of the chromosomes whether the quadrivalents are recorded or not. It is possible to reinterpret Oka's G. D. genes as small translocations where the homologous segments are located on non-homologous chromosomes. The reduction in fertility is expected to be 25% by either of the hypotheses. Similar view was expressed by Stebbins (cited

by Oka[5]), but was not adopted by Oka for lack of positive cytological evidence in favour of translocations.





FIGS. 1–2. Fig. 1. F_1 hybrid, T. 21, × A-18. Diplotene $1_{IV} + 10_{II}$. Fig. 2 F_1 hybrid, T. 21, × A-18. Pachytene. Several differential segments (↗) and heteromorphic terminal ends (↗↗).

In one of the three hybrids studied, 31% of the total chromatin length was unpaired at pachytene, the unpaired regions being expressed as differential segments (Fig. 2). It is considered that these segments represent cases of small translocations, in view of a relatively minor role of inversions in the differentiation of these parents and by the high sterility recorded in these hybrids. The present authors propose the term "differential index" to designate the percentage of the chromatin which is unpaired at pachytene with the hope that it might serve as a useful cytological measure of structural hybridity and thereby permit the prediction of sterility in these hybrids. In the hybrids studied, with an increase in differential index, the sterility exhibited a corresponding increase.

Differential segments unravelled in the present study not only account for sterility, but also the accompanying genetic effects, *viz.*, non-recovery of recombinant phenotypes and the occurrence of various types of abnormal plants which have been interpreted by earlier workers[7] as due to high genetic instability of these hybrids. When bivalents are paired only for a part of their length at early prophase and the unpaired regions represent several interchanges which have attained a balance for viability in the parental combinations, crossing over in the paired segments leads to the production of duplication-deficiencies in the gametes, accompanied by a depression in recombination index. If some of the deletions are viable, the occurrence of the so-called mutations[7] and of *albinas* (Shastry, unpublished) can be adequately explained.

It is concluded from the present study that causes for sterility in *Japonica-indica* rice hybrids are more due to chromosome structural hybridity than to the operation of complementary factors.

We express our gratefulness to Dr. B. P. Pal, Director, and Dr. A. B. Joshi, Head of the Division of Botany, for their interest in the study, and to Dr. M. S. Swaminathan for valuable suggestions.

Division of Botany, S. V. S. SHASTRY.
Indian Agri. Res. Institute, R. N. MISRA.
New Delhi-12, *October* 20, 1960.

1. Henderson, M. T., Yeh, B. P. and Exner, B., *Cytologia*, 1959, **24**, 415.
2. Heieh, S. and Oka, H., *Jap. J Genet.*, 1958, **33**, 73.
3. Kuang, H. H., *Agron. Jour.*, 1951, **43**, 387.
4. Mello Sampayo, T., *Genetica Iberica*, 1952, **4**, 43.
5. Oka, H., *J. Genet.*, 1957, **55**, 397.
6. Sampath, S. and Mohanty, H. K., *Curr. Sci.*, 1954, **23**, 182.
7. Venkateswamy, T., *Associateship Thesis*, Indian Agricultural Research Institute, 1957.
8. Yao, Y., Henderson, M. T. and Jodon, N. E., *Cytologia*, 1958, **23**, 46.

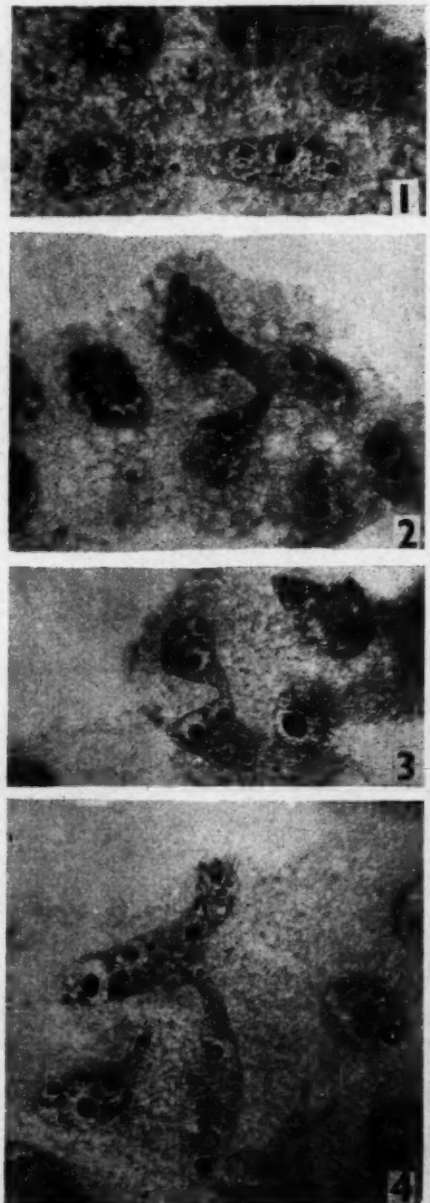
AMITOSIS IN THE ENDOSPERM OF *ZEPHYRANTHES AJAX* SPRENGER

THE term amitosis is applied to nuclear division in which nucleus simply constricts and separates into two or more portions. It was at one time looked upon as the prevailing mode of nuclear division.[4] While this may still be true for the lower forms, it is now known that amitosis occurs in exceptionally rare cases in higher organisms. The amitotic figures have been frequently reported in cells with a nutritive function, such as tapetal, antipodal and endosperm cells of angiosperms. Johansen recorded amitosis in the endosperm of *Zauschneria latifolia*[2] and *Anogra pallida*.[3] Recently, Wang and Chien[5] have reported the occurrence of three different types of amitoses in the cotton endosperm. While studying the cytology of the endosperm of *Zephyranthes ajax* we came across a number of amitotic figures. The details and significance of these are reported in the present paper.

The fertilized ovules of different ages were fixed in acetic alcohol (1 : 3). These were then dissected under a binocular and the endosperm thus taken out was stained with iron-aceto-carmine. The endosperm tissue was not subjected to any pressure. Even the slightest tapping of the cover-slip was avoided.

Amitosis in *Zephyranthes ajax* was seen to commence with the elongation of the nucleus (Fig. 1). The nucleus at this stage showed slight narrowing in its middle region. The narrowing gradually increased, and the constriction became more and more pronounced (Figs. 2 and 3). In very advanced stages the lobes of the nuclei were connected by means of thin chromatin threads. Finally the nuclei broke into two or more parts (Fig. 4). It was observed that when a nucleolus happened to be included in the constricted region, it also underwent similar changes as the nucleus. The amitotic figures appeared more frequently in the free nuclear 4-day-old endosperm than at any other stage of its development. The frequency of the occurrence of amitotic figures decreased with the advancement in the age of the endosperm. In general, nuclear abnormalities including amitosis are of more frequent occurrence in hybrids than in homozygous species. The present findings are in conformity with this as the plant investigated is of hybrid constitution.[1]

The endosperm of *Zephyranthes ajax* in its earlier stages of development showed a significant variation in the size and shape of its nuclei. These nuclei of different sizes and shapes could have arisen as a result of the sequence of changes in amitosis described earlier. One of the possible causes for the variation in the size and shape of nuclei in the



FIGS. 1–4. Stages of amitosis in *Zephyranthes ajax*.

endosperm of *Zephyranthes ajax* may thus be the occurrence of amitosis. It may be stated here that opinions on the question as to whether or not a portion of a nucleus resulting from amitosis can subsequently divide by mitosis are conflicting.

The results reported in this note form part of the work which is being carried out in a research scheme sanctioned by Council of Scientific and Industrial Research, New Delhi. The authors gratefully acknowledge the financial assistance of the Council.

Department of Botany, University of Delhi, Delhi-6, *October* 10, 1960.

S. L. TANDON.
B. M. KAPOOR.

1. Bailey, L. H., *Manual of Cultivated Plants*, Macmillan & Co., New York, 1949.
*2. Johansen, D. A., *Ann. N.Y. Acad. Sci.*, 1931, **33**, 1.
3. —, *Amer. J. Bot.*, 1931, **18**, 854.
4. Sharp, L. W., *Introduction to Cytology*, McGraw-Hill Book Company, New York, 1934.
5. Wang, F. H. and Chien, N. F., *Acta Botanica Sinica*, 1957, **6**, 29.

* Original not seen.

CHROMOSOME NUMBER OF SOME FLOWERING PLANTS

A PERUSAL of literature reveals that the chromosome numbers of the undermentioned plants still remain unexplored. The somatic counts were made from root-tip squashes stained in aceto-orcein followed by pre-treatment with several chemicals, such as, æsculine, coumarin, *para*-dichloro-benzene and oxyquinoline which gave good results. The gametic counts were determined from PMC smears using aceto or propino-carmine. To the best of the knowledge of the author, the chromosome numbers reported in Table I are new records.

TABLE I

No.	Name of plants	Family	Chromosome number n	Chromosome number $2n$
1.	*Eupatorium odoratum* L.	Compositæ	..	58
2.	*Walsura piscidia* Roxb.	Meliaceæ	14	28
3.	*Bursera serrata* Wall. = *(Protium serratum)* (Wall. ex Coleber) Engl.	Burseraceæ	11	22
4.	*Garuga pinnata* Roxb.	do	13	26

The above species whose chromosome numbers have been determined are all of economic importance. *Eupatorium odoratum* grows as weed plant in Bengal. This plant is propagated vegetatively and shows variability in chromosome number of somatic cells, such as $2n = 54$, 56, etc. The oil extracted from the leaves of *E. odoratum* may have insect repellant properties.[1] *Walsura piscidia* does not grow wild being mainly cultivated in gardens for its medicinal value. The members of the Meliaceæ often show polyploidy but the genus *Walsura* (Meliaceæ) seems to represent the true diploid nature. The whole of the Burseraceæ lacks cytological information. The only plant of this family whose chromosome number, as revealed from Darlington and Wylie, *Chromosome Atlas of Flowering Plants*, has been determined is that of *Commiphora berryi* ($n = 13$; $2n = 26$).[2] The present author adds some knowledge by presenting the chromosome numbers of two other members of the Burseraceæ, such as, *Bursera* and *Garuga*. *Bursera serrata* and *Garuga pinnata* are not found to grow as wild plants but are often cultivated in gardens for their medicinal purposes. In these two species, the presence of 'ploidy' and 'secondary association' has also been noted by the present author.

The detailed cytological and embryological studies of these species will be published elsewhere.

My cordial thanks are due to Dr. I. Banerji, for constant encouragement and helpful suggestions and to Dr. S. M. Sircar, for giving necessary facility for this work. My thanks are also due to the Ministry of Education, Government of India, for awarding a Research-Training Scholarship.

Dept. of Botany, Calcutta University, Calcutta, *November* 1, 1960.

RASH BEHARI GHOSH.

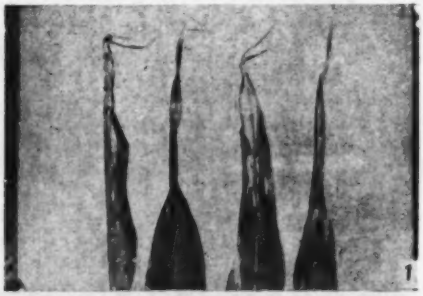
1. Krishnaswamy, N. and Raman, V. S., *Curr. Sci.*, 1949, **18**, 376.
2. Mohni, N. S., and Subramaniam, R. *Indian Forester*, 1960, **86**, 209.

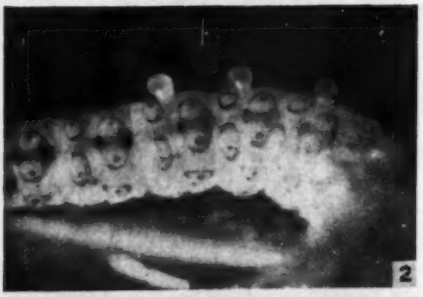
THE NATURAL ENEMIES OF *MARASMIA TRAPEZALIS* (GUEN.), A PEST OF MAIZE AND JOWAR

THE leaf roller, *Marasmia trapezalis* (Guen.), is recorded as a minor pest of millets in South India (Fletcher[1] ; Ayyar[2]). This insect hitherto considered as a pest of minor importance in Northern India, made its appearance in some numbers on young maize and jowar plants at I.A.R.I., in 1958. Since then, the pest has been on the increase and recently there was an outbreak of the insect on jowar and maize crops in and around Delhi.

M. trapezalis caterpillar rolls up leaf tips and fastens the edges with silk and remains hidden in

the rolled leaf. It scrapes the epidermis of leaves and feeds on the green tissue. Leaves damaged by the caterpillar show longitudinal patches and dried leaf tips (Fig. 1). The caterpillar





FIGS. 1–3. Fig. 1. Jowar leaves showing rolled leaves and *Marasmia* damage (reduced). Fig. 2. Early instar grubs of *Goniozus* feeding on host caterpillar (highly enlarged). Fig. 3. Fully grown grubs of *Goniozus* and the host caterpillar (enlarged).

is yellowish green, slender, and becomes very active when disturbed. At I.A.R.I. experimental fields about 40% of the jowar plants were affected, and some of the exotic varieties with broad leaves, had the maximum attack.

An investigation of the cause of the increased infestation of *M. trapezalis* with special reference to biotic factors, was recently taken up by the authors. Preliminary studies have revealed the presence of at least two parasites and a microbial disease, which under favourable conditions, are capable of keeping the pest in check. The present note deals with one of them, a bethylid (*Goniozus marasmi* Kurian) which attacks the larva of *M. trapezalis*.

Goniozus seems to prefer medium-sized larva for parasitisation. In the laboratory, full grown caterpillars are genarally avoided, while younger stages are readily accepted. The female parasite remains in the leaf roll, waiting for the host caterpillar, and rarely takes to flight. When the host is located, the parasite suddenly siezes it by its curved mandibles and keeps the caterpillar pressed down. As soon as the caterpillar becomes quiet, the parasite bends its body around the caterpillar and stabs it in between the first pair of thoracic legs. Apparently a neurotoxin is injected into the main nerve ganglions which brings about an immediate, but temporary paralysis, lasting for nearly 30-40 minutes. Soon after paralysing the host, the parasite drags it to a suitable place and commences oviposition. The female first walks over the host and examines it with its mandibles and ovipositor. If a parasitised host is offered to the female parasite, it invariably feeds on the eggs and young grubs already present. The habit of feeding on the host body fluids that exude from wounds on hosts is commonly met with in many parasitic hymenoptera, but this peculiar habit of preying on its own species seems to be rather interesting. After cleaning the host of the parasite grubs and eggs already present, it starts probing the host body with its ovipositor for a suitable site to fix the egg. When a suitable place is located, which is generally on the dorso-lateral region in between the two lateral setae, the tip of the ovipositor is pressed against the host body and the egg starts descending down. The eggs are glued firmly to the host cuticle in a transverse position. After laying an egg it shifts the abdomen to the opposite side and then lays another on the opposite side. Then it moves forward and lays two more eggs in the next abdominal segment. In this way, a parasite laid 6 eggs at one sitting in the laboratory, in the course of about 40 minutes. The parasitised caterpillar recovers from the sting in about half an hour and continues to move and feed.

The eggs of *Goniozus* are elongate, glistening white, and not easily detected on the host. The egg period is quite short and the grub on hatching remains anchored to the host at the same spot and feeds on the host body fluids (Fig. 2). Even after the parasite grubs have grown to some size the host is capable of slight movement. The grub completes its development in about 2 days at the expense of the host

caterpillar which is devoid of its body contents, resulting in death (Fig. 3). The pupal period under laboratory conditions varied from 5-6 days.

The preliminary observations have shown that the parasite has many qualities which indicate its efficiency as an agent of control. It has a very short life-cycle as compared to that of the host, the adult life is long, and it possesses the ability to search for, find and successfully attack the host even when the host population is low. The increased infestation of *M. trapezalis* on jowar may be partially attributed to the adverse effects of modern insecticides which have come to be generally recognised and accepted since the advent of powerful organic insecticides. The use of insecticides on crops can be better integrated with biological control by changes, deletions, modifications of timing, dosage, or method of application.

Our sincere thanks are due to Dr. B. P. Pal, Director, Dr. E. S. Narayanan, Head of the Division of Entomology, for the facilities, and to Prof. S. Pradhan, for his keen interest in the problem. Thanks are also due to Dr. K. O. Rachie, Sorghum Specialist, Rockefeller Foundation, for the facilities extended for work on insect problems in jowar.

I.A.R.I., Division of Entomology, New Delhi, *September* 24, 1960.

T. V. VENKATRAMAN.
M. J. CHACKO.

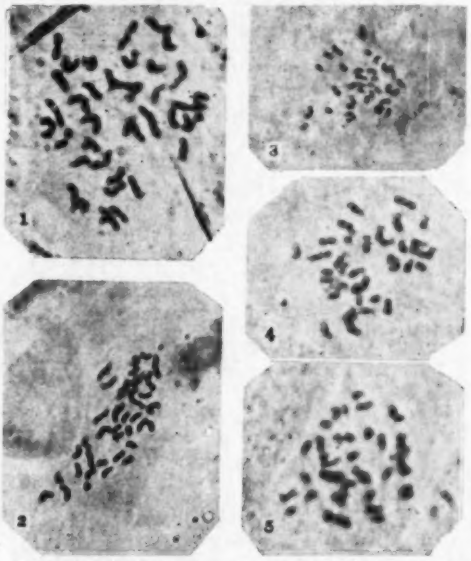
1. Fletcher, T. B., *Some South Indian Insects.*, 1914, pp. 432-33.
2. Ayyar, T. V. R., *Handbook of Economic Entomology for South India*, 1940, pp. 180.

THE CHROMOSOME NUMBERS OF A FEW MORE ORCHID GENERA

In a previous communication (Sharma and Chatterji, 1960), chromosome numbers of nine different species of Orchids were reported, noted in connection with the detailed cytological work undertaken, in this laboratory. In the present report, chromosome numbers of five more species are being reported. Of these, *Cymbidium lowianum*, *C. munronianum*, and *Renanthera imschootiana* belong to the tribe Vandeæ, whereas *Arundina bambusæfolia* and *Cœlogyne corymbosa* fall under the tribe Epidendreæ. The chromosome numbers are :—

1.	*Cymbidium lowianum* Rchb.f. ..	$2n=40$	(Fig. 1)
2.	*C. munronianum* King and Pantl.	$2n=40$	(,, 2)
3.	*Renanthera imschootiana* Rolfe	$2n=38$	(,, 3)
4.	*Arundina bambusæfolia* (Roxb.) Lindl.	$2n=40$	(,, 4)
5.	*Cœlogyne corymbosa* Lindl. ..	$2n=38$	(,, 5)

It may be noted that both $n=19$ and 20 chromosomes have been found in other species of Vandeæ as well (Storey, 1953 ; Miduno, 1938, 1940, 1954, etc.). It appears that the genus *Cymbidium* is quite a homogeneous one in which all the species so far reported contain $n=20$ chromosomes (Wimber, 1957). With



FIGS. 1-5. Fig. 1. Somatic metaphase of *Cymbidium lowianum* showing 40 chromosomes (× 2,000). Fig. 2. Somatic metaphase of *C. munronianum* showing 40 chromosomes (× 1,400). Fig. 3. Somatic metaphase of *Renanthera imschootiana* showing 38 chromosomes (× 1,200). Fig. 4. Somatic metaphase of *Arundina bambusæfolia* showing 40 chromosomes (× 2,100). Fig. 5. Somatic metaphase of *Cœlogyne corymbosa* showing 38 chromosomes (× 2,100).

regard to the genus *Cœlogyne*, all the three species explored by previous workers (Hoffmann, 1930) contain $2n=40$ chromosomes, whereas in the present investigation 38 chromosomes have been found. It appears, therefore, that as in *Orchis* (Vermuelen, 1947 ; Hagerup, 1938), in this genus too, aneuploidy is prevalent.

Cytogenetics Laboratory, Dept. of Botany, Calcutta University, Calcutta-19, *September* 1960.

A. K. SHARMA.
A. K. CHATTERJI.

1. Hagerup, O., *Hereditas*, 1938, **24**, 258.
2. —, *K. dansk., vidensk. Selsk. Biol. Medd.*, 1939, **20** (9), 1.
3. Hoffmann, K. M., *Planta*, 1930, **10**, 523.
4. Miduno, T., *Cytologia*, 1938, **8**, 505.
5. —, *Ibid.*, 1940, **11**, 179.
6. —, *Ibid.*, 1954, **19**, 239.
7. Sharma, A. K. and Chatterji, A. K., *Proc. Ind. Sci. Cong. 47th Session* (Bot. Sec.), 1960.
8. Storey, W. B., *Bull. Pacif. Orchid Soc.*, Hawaii, 1953, **11**, 17.
9. Vermuelen, P., *Studies on Dactylorchids*, Utrecht, 1947.
10. Wimber, D. E., *Amer. Orchid Soc. Bull.*, 1957, **26** (9), 636.

REVIEWS

Introduction to Quantum Field Theory. By F. Mandl. (Interscience Publishers Inc., New York), 1959. Pp. vi + 202. Price $ 16.00.

During the past few years a number of books have appeared on the quantum theory of fields, but practically all are written in such an abstract and condensed style that they are either uninteresting or unitelligible to the majority of physicists. A book that explains the principles of the field theory in a language that is mathematically not difficult will therefore find reception amongst all physicists, theoretical or experimental, and the book by F. Mandl is to be welcomed for this reason.

In about hundred and sixty pages which are distributed in twenty-two chapters, the author explains the basic ideas of field quantisation which would enable the reader to gain mastery over the modern perturbation-theoretic methods of quantum field theory. The author has developed the subject on the basis of the ideas of Dyson and Feynman, which enable one to interpret mathematical expansions corresponding to decay or interaction processes between elementary particles in terms of simple graphs. The first eight chapters of the book deal with quantisation of fields and in these the author derives the commutation rules for different types of fields, *e.g.*, boson, meson, and fermion fields. Chapters nine and ten deal with photons and the quantisation of electromagnetic fields. Since the coupling constant between the electromagnetic and electron fields is weak, the perturbation theoretic procedure is quite rigorous for this interaction, and consequently relativistic quantum field theory has its most striking successes in quantum electrodynamics. In these chapters, the author gives the commutation relations satisfied by the components of the electromagnetic field and further develops the Gupta-Bleuler formalism here. Chapters twelve and thirteen deal with the scattering matrix or the so-called S-matrix and final chapters of the book treat topics such as Compton scattering, Feynman diagrams, Radiative corrections, Vacuum polarisation and Renormalisation theory.

The book is supplemented by a number of exercises which would help the student to gain a mastery of the principles and techniques of the subject. The book is warmly recommended to all students of the quantum theory of fields.

V.

Principles of Modern Physics. By Robert B. Leighton. (Published by McGraw-Hill Book Co., Inc., New York), 1959. Pp. 795. Price $ 12.50.

This book by Prof. Leighton is a carefully thought-out and well-planned book on modern physics. It covers a broad range of subjects and at the same time would take the student sufficiently deep into the various aspects of modern physics. The treatment is fairly advanced and assumes on the part of the students using the book not only a good preliminary knowledge of the fundamental facts of modern Physics such as atomic theory and atomic spectrum, heat radiation, kinetic theory and radioactivity, but also a good background knowledge of different branches of mathematics. A third of the book is devoted to nuclear physics. It includes such recent advances in physics as the band theory of solids, non-conservation of parity, strange particles, Fermi mechanism of cosmic ray acceleration, nuclear shell structure, formation of elements in stars, etc.

If a student really wants to understand modern physics and not merely "learn" it for an examination, then this is the book for him. The numerous examples interspersed as part of the text will try his ingenuity and clear thinking before he could proceed further. The book is recommended not only for the final year University students in physics but also to those who are engaged in physical research. A. S. G.

Proceedings of the Cosmic Ray Symposium, 1960. (The Cosmic Ray Research Committee of the Department of Atomic Energy, Government of India, in Conjunction with Physical Research Laboratory, Ahmedabad), 1960. Pp. xii + 446. Price not given.

The Cosmic Ray Research Committee of the Department of Atomic Energy, Government of India, organises every year a symposium on Cosmic Rays. The sixth symposium was held at Ahmedabad on March 16-19, 1960. A welcome practice was adopted last year to bring out the proceedings of the symposium in a collected form so as to make them easily available not only to the participants but also to all workers, laboratories and institutions interested in this important field of research.

The present volume of the *Proceedings* begins with the contents of the lecture "Origins of

Cosmic Rays" delivered by Prof. P. Morrison of the Cornell University, U.S.A., when he inaugurated the Symposium. Prof. Morrison has indicated a fruitful approach to the study of the origins of cosmic rays, namely, to regard them as a natural part of the evolution of stars and of galaxies. The volume contains 62 papers which were presented and discussed at the symposium in which about an equal number of workers from different parts of India participated. The papers cover nearly all aspects of cosmic ray research, such as origin of cosmic rays, their time variations, solar and terrestrial relationships, geomagnetic activity, extensive air-showers, high-energy nuclear interactions, radio-isotopes produced by cosmic rays and their geophysical applications, instrumentations in cosmic ray studies, etc.

The editors deserve congratulations in having brought out the *Proceedings* in less than six months of the symposium. This has been made possible by having recourse to cyclostyled printing. The *Proceedings* wil be useful to all research workers in cosmic ray physics as they contain latest results and developments in this field. The discussions at the end of each paper and the references to current literature, add to the value of the book.

A. S. G.

Jets and Rockets. By A. Barker, T. R. F. Nonweiler and R. Smelt. (Chapman & Hall Ltd., London), 1959. Pp. 268. Price 35 *sh.*

The object of the book is to provide an introductory text-book on all forms of jet propulsion, rocket, turbojet, pulse jet, etc., and on the whole it achieves this purpose well. The main features of each power plant are described clearly and the calculations of thrust coefficients and fuel consumption are given. Emphasis is made on high speed aerodynamics of jet propulsion. The book concludes with a chapter on future developments, appendices of useful data, and a bibliography. Though somewhat out of date, the book contains much useful information which beginners in the subject will appreciate.

A. S. G.

A Guide-Book to Biochemistry. By Kenneth Harrison. (Cambridge University Press, London N.W. 1), 1959. Pp. 150. Price: Cloth Edition 17 *sh.* 6 d.; Paper Edition 10 *sh.* 6 d.

Although there are several good text-books on this rapidly growing subject of biochemistry, they are either too long or too specialised. For the beginner in the subject or for those working in other allied disciplines who would like to keep themselves abreast in this field of study by attempting to follow the continuous flow of papers that are being published, there is a need for an introductory book on biochemistry. This little book of about 150 pages excellently serves this purpose.

After a short introductory chapter, describing the chief branches of research in biochemistry, the subject is developed in a logical way dealing with catalysis by enzymes and energy production through oxidative mechanisms. There is a chapter on photosynthesis which is followed by three chapters respectively on carbohydrate metabolism, fat metabolism and protein metabolism. The last chapter deals with control of metabolism.

The paper cover edition at cheaper price will be welcomed by many.

A. S. G.

New Books in Applied Mathematics and Mathematical Physics. (Dover Publications, Inc., 180, Varick Street, New York-14, N.Y.)

Dover Publications, whose inexpensive editions of basic scientific texts are well known to students and workers in technical fields, has recently republished the following five books in their series of texts in advanced mathematics and mathematical physics.

Statistics Manual (pp. 288, Price $1.55) written by Dr. Edwin L. Crow in collaboration with Frances A. Davis and Dr. Margaret W. Maxfield. This is a comprehensive collection of classical and modern methods of making statistical inferences, designed for all those who work in fields using statistics. It contains amongst other topics, determination of sample size, relations of means and variances, chi-square runs, quality control, acceptance sampling, etc. The many examples taken from ordnance development will prove useful to workers in all fields. A special feature of the book is the appendix of 21 tables and 11 charts, some of which are difficult to find elsewhere.

Algebras and Their Arithmetics by Leonard Eugene Diekson (pp. 241, price $1.35). This provides the background necessary to a complete understanding of the general theory of algebra. The author begins with an elementary introduction to linear transformations, matrices, and the field of complex numbers. This is followed by a discussion of order, basal units, modulus and quaternions. Then follow chapters which describe various examples of algebras, including invariant difference, nilpotent,

and division algebras. The principal theorem on algebras is proved in a rigorous exposition as preparation of quadratic numbers, reducible polynomials, and the normal form of integral algebraic numbers. Then comes the chapter on the Arithmetic of an Algebra which include generalized quaternions and application to Diophantine equations. The last chapter deals with the properties of fields. The exposition is clear and at the same time rigorous.

Co-ordinate Geometry by Luther Pfahler Eisenhart (pp. 298, price $ 1.65). Mr. Eisenhart's work is well known to students of mathematics, as affording a thorough, complete and unified introduction to the subject. The large number of exercises throughout the text will prove particularly helpful to students.

Differential Equations for Engineers by Philip Franklin (pp. 300, price $ 1.65) will be useful for physicists, engineers and applied mathematicians. Broader in scope and treatment than most books in the field, this work is an outgrowth of a course given by the author for over ten years at the Massachusetts Institute of Technology.

The Applications of Elliptic Functions by Alfred George Greenhill (pp. 357, price $ 1.75). A basic text on the use of both elliptic integrals and functions, this book has never been excelled for careful attention to every detail of solution. Although written in 1892, the book can still be recommended to students of applied mathematics today.

These five additions to the Dover programme should prove valuable items in the library of every student of science.

Progress in Inorganic Chemistry. Edited by F. Albert Cotton (Interscience Publishers, New York, London), Vol. I. 1959. Pp. 566 + vi. Price $ 14.50 ; Vol. II. 1960. Pp. 399. Price $ 10.50.

It has become increasingly difficult for both an academician and an industrial chemist to keep abreast with the advances that are being made in the field of Inorganic Chemistry which has grown so wide that it has become very hard to define what constitutes "Inorganic Chemistry". The variety of topics that are presented in this series will attest such a difficulty. As the Editor has rightly pointed out in his Introduction, the scope of Inorganic Chemistry has expanded considerably in recent years to include the organo-derivatives, mixed oxide systems, quantum mechanical treatment of spectral and magnetic properties, and catalytically active surfaces, in addition to the preparation and a study of properties of a host of new compounds by classical methods. The tentacles of inorganic chemitry have thus pervaded into the various branches of physical and organic chemistry with a view to correlating the electronic structure of the atom and the nature of the chemical bond with the several physico-chemical properties.

From this point of view, it is gratifying to note that in the first volume considerable space in the contributions is devoted to give a critical survey of the structural features of the compounds employing various modern techniques. In fact in some cases even the classification of the compounds is based on the structural considerations. The correlation of the physico-chemical properties of the compounds with the nature of the chemical bond and the electronic structure of the atom has placed the vast experimental data on a logical basis.

The authors of the several contributions to these volumes are active research workers who are well known in their fields of specialisation and have given authoritative accounts of the various topics along with up-to-date references for further reading.

The first volume deals with the following topics : (1) Cyclopentadienyl and Arene Metal Compounds, by G. Wilkinson and F. A. Cotton ; (2) Interstitial Compounds of Graphite by G. R. Hennig : (3) Uber-Schwefel-Sticktoff-Verbindungen, by Margot Becke-Goehring ; (4) Metal-Ammonia Solutions, by W. L. Jolly ; (5) Isocyanide Complexes of Metals, by L. Malatesta ; (6) The Effect of Inner Orbital Splitting on the Thermodynamic Properties of Transition Metal Compounds and Co-ordination Complexes, by P. George and D. S. McClure ; (7) The Structure and Properties of Mixed Metal Oxides, by R. Ward.

The seven topics dealt with in the second volume are : (1) Radioactivation Analysis in Inorganic Geochemistry, by John W. Winchester ; (2) Halides and Oxyhalides of the Elements of Groups Vb and VIb, by John W. George ; (3) Extraction of Inorganic Compounds into Organic Solvents, by R. M. Diamond and D. G. Tuck ; (4) Some Fluorine Compounds of the Transition Metals, by R. D. Peacock ; (5) Intensities of Spectral Bands in Transition Metal Complexes, by C. J. Ballhausen ; (6) Unusual Oxidation States of Some Actinide and Lanthanide Elements, by L. B. Asprey and B. B. Cunningham ; (7) Metal Alkoxides, by D. C. Bradley.

In an attempt to make the volumes international in character, it has been suggested that contributions might appear in English, French or German depending upon the proficiency of the author in the language, but the reviewers are of the opinion that the utility of the contributions would be enhanced if all the articles appear in English. There is no doubt that these volumes will be found very useful both to the research worker in the field and to the University teacher dealing in advanced topics in Inorganic Chemistry.

M. R. A.
A. R. V.

Radioactivity for Pharmaceutical and Allied Research Laboratories—A Symposium Sponsored by Nuclear Science and Engineering Corporation. Edited by Abraham Edelmann. (Academic Press, New York; India: Asia Publishing House, Bombay-1), 1960. Pp. xii + 171. Price $ 6.00.

The employment of radiation techniques in solving the problems of the pharmaceutical and related industries has been rather limited so far. This volume, presenting the proceedings of a Symposium, deals with the principles, methods and areas of usefulness of radioactivity in the pharmaceutical and allied sciences. Problems one has to face in pioneering a new technology have been vividly described. Development of electron beam irradiation process for sterilizing surgical sutures, application of isotope dilution techniques to the analysis of drugs as exemplified by γ-isomer content in benzene hexachloride and determination of penicillin G in fermentation broth, biosynthesis and metabolic studies of C^{14} oxytetracycline, evaluation of the tranquilizer, reserpine and use of radioisotopes in soap, detergent and cosmetic research are but a few illustrations of the potential usefulness of radioactivity.

Development of a bioassay technique for granulocytopænia, production of cataracts and the phenomenon of accelerated ageing as a result of ionizing radiations depict how even the adverse effects by biological radiations could be used as experimental models for evaluating drugs and studying the problems of gerontology. The isotope development programme of the U.S. Atomic Energy Commission, detailed in the last chapter, reveals the increasing interest evinced and the measures taken in expanding the industrial uses of radioisotopes.

M. Sirsi.

Harb. I.M.I. Handbook: By J. C. F. Hopkins and others. (Commonwealth Mycological Institute, Kew, England), 1960. Pp. 103. Price 12 *sh.* 6 *d.*

We welcome this delightful little handbook of methods in use at the Commonwealth Mycological Institute. For those of us, like the reviewer, who had the privilege of working at the C. M. I. for sometime, most of the techniques and procedures described in this book are familiar and have always been the focus of admiration. However, many mycologists and plant pathologists are not familiar with these and the publication of this handbook is therefore an event of great importance. Even, in the Herb. Crypt. Indiæ Orientalis at New Delhi, few of the methods outlined here are followed, although it is India's oldest mycological Herbarium. This book is particularly recommended for reading by those in charge of this Herbarium and others in charge of smaller Herbaria in other Institutions in India. Indeed, everyone interested in the study of fungi, in establishing and building up a Herbarium, and in maintaining established ones, will find in this book clear and precise descriptions of the techniques and procedures which they need and should follow.

Dr. Hopkins (Director, C.M.I.) introduces the book, with a dedication to Mr. E. W. Mason (former Mycologist) which is very appropriate. It is perhaps no exaggeration to say that most of the techniques or procedures evolved at the C.M.I. were inspired by him during his long association with the Institute. In the introductory chapter, Dr. Wiltshire (former Director) covers the entire range of the activities of the Institute in contributing to our knowledge of fungi and in serving the needs of plant pathologists and of pure and applied mycologists all over the world. This is followed by chapters on "The Herbarium" by Dr. M. B. Ellis, "How to describe a fungus" by Dr. F. C. Deighton, "Laboratory methods used in the culture collection" by Major H. A. Dade, "The treatment of important pathogenic Phycomycetes" by Dr. G. M. Waterhouse, "Bacteria and the Herbarium" by Dr. A. C. Hayward, "Collecting fungi" by Dr. C. Booth, "Collecting in the tropics" by Dr. Deighton, "Collecting in the clinic" by Dr. G. C. Ainsworth, "The *Index of Fungi*" by Dr. Deighton, "The *Bibliography of Systematic Mycology*" by Dr. Waterhouse, "The Herbarium and the *Review of Applied Mycology*" by Dr. E. B. Martyn, and "The *Review of Medical and Veterinary Mycology* and the Herbarium" by Dr. Ainsworth. A list of the

C.M.I. staff and of C.M.I. publications is appended.

Students, teachers, research workers and even professional plant pathologists and mycologists would be able to learn much by a reading of the different chapters of this book. A special tribute, however, is paid here to the chapter on Culture Collection Techniques by Major Dade which is admirably written in typical "Dadean" fashion and provides delightful reading. It is a most instructive chapter worth reading repeatedly since it contains details of techniques which every mycologist should be familiar with. It could not have been written better by any one else. A similar tribute is paid here to the chapter on Herbarium by Dr. Ellis. The chapter on pathogenic phycomycetes by Dr. Waterhouse reflects the interest in pathogenic forms and perhaps it would have been most useful if the techniques for the isolation of other aquatic forms had also been elaborated a little more, although it must be admitted that a reference has been made to Emerson's excellent paper in *Mycologia* (1958, 50, 589). I am sure, like the useful and indispensable *Dictionary of Fungi* which first appeared in 1943, this little handbook will also grow and a second, slightly more enlarged edition will appear in due course. Even in its present form I would rank this as one of the most useful books on mycological techniques that has ever appeared.

Dr. Hopkins and the Commonwealth Agricultural Bureau are to be congratulated for bringing out this excellent book which contains the quintessence of many years' careful and critical work aimed at evolving techniques of collection and preservation of fungi, of maintenance of Herbaria and of living culture collections and also procedures for indexing the taxonomic and other literature on fungi and literature on applied mycology and plant pathology. The book is well got up and moderately priced. Everyone interested in the study of fungi should have a copy, should study it thoroughly and it would be most rewarding if the procedures outlined are followed.

C. V. SUBRAMANIAN.

The Land and Freshwater Mollusca in the Collection of the Madras Government Museum—*Bulletin of the Madras Government Museum*, New Series, Natural History Section, Vol. VI, No. 4, 1960. Pp. 174, 21 plates.

Very few will disagree with the view that to know one's own country—its geophysical, geographical, and biological features, its peoples and their history and culture—is itself a liberal education. Our Natural History Museums may be said to have fulfilled their paramount education function if they gather, preserve, describe, display, and interpret natural history objects found not only within the boundaries of one's country, but also determine such relations as may exist between them and their nearest congeners outside it.

The series of Bulletins of the Madras Government Museum which have been issued since 1927 contain original descriptive accounts relating to the fauna, flora, peoples, and monuments of South India, and the present No. 4 of Volume VI of the series under review is one such dealing with the land and freshwater snails and clams in the collection of the museum, and its author, Dr. S. T. Satyamurti, has explained in his introduction the need for "a clear handlist of, at least, the commoner species in their modern sequence" which would be "readily appreciated not only by students and systematists but also by amateurs who wish to collect shells of inland species, and arrange, name, and classify them in a scientific way."

The descriptive account of about 120 species of land and freshwater mollusca which covers 142 pages is followed by (1) an essential bibliography on the subject, (2) an appendix listing new records of species, and (3) an index (covering 11 pages) of not only the genera and species but also of certain common or popular words and technical terms used in the text, which are italicised.

The reviewer wishes that the original spellings of place-names had been bracketed and their modern variants added to avoid confusion, and the localities grouped according to the states to which they belong. The illustrations of species on plates are clear and helpful. The author deserves the thanks not only of all malacologists and conchologists but also of students for placing in their hands a handbook of this kind as a help towards a clearer understanding of the correct classification and relationship of the species dealt with.

H. S. R.

Nepal. By Pradyumna P. Karan (University of Kentucky Press, Lexington), 1960. Pp. 100. Price $ 10.00.

An extensive and comprehensive survey of the tiny Himalayan kingdom of Nepal has been made by Dr. Pradyumna P. Karan in his book *Nepal*. The volume covers most aspects one can think of including the geographical features,

mineral resources and scientific potentialities set against the historical, political and cultural background of the country. The book bears evidence of the first-hand knowledge of the author and its claim to be the "first physical and cultural geography of Nepal" seems justified. The textual information is supplemented by 35 full-page maps presenting essential features regarding geography, climate, agriculture, geology, mineral resources, industry, population, health, political divisions, etc. There are also included in the book a large number of photographs which the author himself had taken. The book besides being popular will be of topical interest.

The book is well got up and printed on high-class paper 14" × 10½". The jacket in the cover contains a large-scale map of Nepal's administrative divisions showing the boundaries of the country's 491 thums (counties). This map is claimed to be the first ever made. Considering the many good features of the publication the price marked cannot be regarded as too high. U. G.

Water and Agriculture: A Symposium presented at the Washington Meeting of the American Association for the Advancement of Science, December 1958. (Publication No. 62 of the Association, Washington D.C.), 1960. Pp. 206. Price $ 5.00.

This publication of nearly 200 printed pages contains 17 papers contributed by recognized authorities in their own subjects. The papers have been grouped into 4 parts dealing respectively with (i) Water for the future, (ii) Water sources, (iii) Water planning and use, (iv) Technique of water control. Although the papers deal with conditions in U.S.A., some of them are of great interest to us in India where all possible steps are being taken to develop and utilize our still underdeveloped water resources to increase agricultural production.

All the papers contributed to the symposium are important but special mention may be made of some. The paper on the "beneficial effects of weather modification in augmenting water supplies and the development of techniques that will make it possible" should interest meteorologists engaged in creating artificial rains. The paper on "use of climatic data in guiding water management on the farm" shows the type of investigations that should be necessary in India to make the most efficient use of our water resources. There are also contributions on Soil Conservation practices and availability of water, Forest management in increasing water yields, and Agricultural Drainage. The book deserves a careful perusal as it contains valuable information of interest to both Agricultural Scientists and Irrigation Engineers. K. R.

Cotton in India : A Monograph, Vol. II. (Issued by the Indian Central Cotton Committee), July 1960. Price Rs. 30 or 45 *sh.*

This is the second volume of a series of four programmed, and the first volume appeared in February 1960 and was reviewed in November issue of *Current Science*. The present volume deals in five chapters with Physiology, Agronomy, Diseases, Insect and Mite Pests and Seed Multiplication and Distribution.

Part of the information on Physiology had already appeared in the *Scientific Monograph No.* 3 of the Indian Central Cotton Committee. Spacing as affecting the development and production in the American cotton grown under varying conditions is discussed and its importance stressed. The role of micronutrients is briefly dealt with, and it is shown, that in soils alkaline in reaction, application of chromium, zinc and manganese increases yields. Experiments with chemical hormones have shown that MAA applied at the reproductive phase gives significant yield increases in *desi* cotton. The physiological causes of bud and boll shedding are still unknown. It is clear that there is still considerable lacuna in our knowledge on the physiology of cotton needing intensive studies.

The chapter on Agronomy mentions the advantages of early sowing, of the growing of a leguminous crop preceding cotton in the rotation and mixed cropping in tracts of low rainfall. The general tillage and cultural practices followed in different cotton areas of India are described and a summary is given of the results of manurial experiments. These results indicate the value of nitrogen and also the optimum period of application to *desi* and American cotton grown in different areas. Information is given on the optimum quantities of water needed by American and *desi* cotton and also when to irrigate. A list of improved varieties of cotton and their characteristics is given in the end which rather appears out of place and could well have gone into the last chapter dealing with seed. This is the only chapter in the book which is purely descriptive without reference to experimental data and literature, and could have been more suitable for a popular treatise.

The chapter on cotton diseases gives a good description of all the known diseases of cotton caused by fungus, bacteria and nematode, their

symptoms, etiology and control measures. Similarly, the chapter on insect and mite pests provides detailed information on the life-histories of the various pests, their natural enemies, their alternate hosts and control measures. There is a long list of the pests occurring on cotton, in different states given at the end. Critical information on the relative importance of the different pests in particular areas and the usual time of their occurrence would have proved much more valuable.

The last chapter on seed multiplication and distribution gives a good account of the early history of cotton-seed schemes in the country, and how the Indian Central Cotton Committee since its inception has been supporting seed schemes with financial help to states. The technique of multiplying seed is described and reference could have been made to Harland's elite method. There has been remarkable progress since the Plan period both in total production and in the production of long staple cotton. The latter which formed only 15% of production in 1947-48 has gone up to 41% in 1956-57. The area covered by improved varieties has also progressed which was 72% in 1956-57. There has been further additions to the list of improved varieties since the monograph was written.

There is a difference between Volume I and Volume II in that the subject-matter of the latter is all handled by men who are active workers in the particular fields. A perusal of Volume I by one acquainted with cotton research in India created an impression that in the compiling of the information the authors of particular chapters had not given due credit to the earlier workers in the field. The present volume is however free from such criticism. For the first time all available scientific information on cotton has been brought together and it clearly establishes the great progress that has been made in cotton research in the country.

K. R.

A Bibliography of Indology, Vol. 1. *Indian Anthropology.* Compiled by J. M. Kantikar, edited, revised and enlarged by D. L. Banerjee and A. K. Ohdedar, Calcutta. (The National Library), 1960. Pp. xii + 290 (two columns per page). Price Rs. 5·00.

Sri. B. S. Kesavan, Librarian of the National Library, explains that this is the first volume of a series of Bibliographies of basic publications on all aspects of Indian Culture. This Bibliography was compiled mainly from materials available in the National Library but data were also collected from many other libraries and institutions. Literature appearing in journals has, however, been 'sparingly drawn upon', because other Bibliographies, such as the one compiled by Elizabeth von Furer-Haimendorf, have devoted considerable attention to it. Most of the entries in the Bibliography under review are annotated with carefully selected quotations from reviews, prefaces or forewords. The result is a useful compilation. Within the limits deliberately set by those who planned the volume, this Bibliography amply achieves the intended purpose. The data have been carefully grouped, first region-wise and then subject-wise. Exhaustive author and subject indexes at the end increase the usefulness of the book.

The book is good value at five rupees, but this reviewer wishes that more durable binding than cardboard had been used. In a book of this kind which is expected to be in regular use, binding is of the utmost importance.

The National Librarian and his staff deserve our thanks for a timely and useful publication. We will look forward to other volumes in this series with great expectation. T. N. MADAN.

Books Received

An Introduction to Astrodynamics. By Robert M. L. Baker Jr. and Maud W. Makemson. (Academic Press Inc. Pub., New York 3, N.Y.), 1960, Pp. xiv + 358. Price $ 7.50.

Beautiful Climbers of India. By B. P. Pal (Indian Council of Agricultural Research, New Delhi-12), 1960. Pp. 105. Price Rs. 8·00.

The Ethical Animal. By C. H. Waddington. (George Allen & Unwin Ruskin House, London W.C. 1), 1960. Pp. 230. Price 25 *sh.*

The Nature of the Universe. By Fred Hoyle (Macmillan & Co. Ltd., London W.C. 2), 1960. Pp. vii + 103. Price 8 *sh* 6 *d.*

Biochemical Society Symposia—No. 19—Steric Aspects of the Chemistry and Biochemistry of Natural Products. (Cambridge University Press, London N.W. 1), 1960. Pp. vii + 137. Price 20 *sh.*

Cotton in India—A Monograph, Vol. III. By C. Nanjundayya, R. L. N. Iyengar. *et. al.* (Indian Central Cotton Committee, P. B. No. 1002, Bombay-1), 1960. Pp. viii + 295. Price Rs. 30·00.

Homology Theory—An Introduction to Algebraic Topology. By P. J. Hilton, S. Wylie. (Cambridge University Press, London N.W. 1), 1960. Pp. xv + 484. Price 75 *sh.*

SCIENCE NOTES AND NEWS

Award of Research Degrees

Annamalai University has awarded the Ph.D. degree in Chemistry to Miss M. Uma for her thesis entitled "A Study of Some Steric and Polar Effects by Spectral and Dipole Moment Measurements".

Indian Botanical Society

The following were elected as Office-bearers of the Society for the year 1961 : President and Hony. Secretary : Prof. J. Venkateswarlu, Waltair ; Vice-Presidents : Dr. I. Banerji, Calcutta, Prof. P. N. Mehra, Chandigarh ; Hony. Treasurer and Business Manager : Prof. T. S. Sadasivan, Madras. The Editorial Board for the year 1961 will consist of : Rev. Fr. H. Santapau, Prof. P. Maheshwari, Dr. B. P. Pal and Prof. R. Misra.

Regional Seminar on Scientific Documentation in South Asia

The UNESCO South Asia Science Co-operation Office (SASCO) is organizing a Regional Seminar on Scientific Documentation, March 7-16, 1961, at the Indian National Scientific Documentation Centre (INSDOC), National Physical Laboratory, Hillside Road, New Delhi. The Government of India have kindly offered to act as host to this Seminar.

The Seminar will consider the needs of countries in Asia for scientific documentation, survey the nature and scope of existing scientific documenatation facilities in Asia and their availability for use in the region, consider the facilities obtaining areas outside South and South-East Asia which may be useful to assist further developments in the region, consider the selection and training of personnel and the problem of equipping centres and make recommendations for future improvement of scientific documentation work in the region.

Further particulars can be obtained from the UNESCO South Asia Science Co-operation Office, 21, Curzon Road, New Delhi.

Raptakos Medical Research Fellowships

The Raptakos Medical Research Board Fellowships for the year 1961 have been awarded to the following candidates : Sri. A. Irudayasamy, State Forensic Sciences Laboratory, Madras ; Dr. Naunehal Singh, All-India Institute of Medical Sciences, New Delhi ; Dr. Prasanta Basu, Institute of Postgraduate Medical Education and Research, Calcutta ; Miss Chitra Roy, Indian Cancer Research Centre, Parel, Bombay-12 ; Shri A. K. Deb, Indian Institute of Science, Bangalore-12 ; Shri T. N. Pattabiraman, Christian Medical College Hospital, Vellore.

18th International Congress of Pure and Applied Chemistry

The 18th International Congress of Pure and Applied Chemistry will be held in Montreal, Canada, from August 6 to 12, 1961.

Plenary lecturers who have accepted to participate are : Prof. F. S. Dainton, England ; Prof. R. Daudel, France ; Prof. G. Schwarzenbach, Switzerland ; Prof. R. H. Wilhelm, U.S.A. ; and Academician N. N. Semenov, U.S.S.R.

Some 70 sectional lectures will be delivered on the various aspects of the following four divisions of chemistry with which the Conference will deal : I. *Physical Chemistry* : (*a*) Structure and Reactivity of Small Molecular Species, (*b*) Solid State, (*c*) Chemical and Thermodynamic Properties at High Temperatures, (*d*) Nuclear Chemistry ; II. *Applied Chemistry* : (*a*) Structure and Catalytic Activity of Metal Surfaces, (*b*) Metallurgical Processes, (*c*) Electrochemistry, (*d*) Plastics and High Polymers, (*e*) Wood Chemistry Symposium (invited papers only) ; III. *Analytical Chemistry* : (*a*) Analysis of Metals and Minerals, (*b*) Analytical Chemistry of the Less Common Metals, (*c*) Analysis of Pesticide Residues ; and IV. *Organic Chemistry Symposium* : Dynamic Stereochemistry (invited papers only).

Hydrospheric Origin of Lunar Surface Features

The large and smooth appearance of the lunar maria has generally been viewed as sufficient evidence to identify their surfaces as lava flows. The arguments for lava presuppose the absence of a lunar atmosphere or hydrosphere lasting any significant length of time. However, during the past few decades geophysical as well as geological investigations have made clear that the present atmosphere and hydrosphere of the Earth are not residual from primordial antecedents, but are almost of secondary origin, being formed by exudation from the Earth's interior.

In an article contributed to *Nature* (1960, 188, 886), J. J. Gilvarry considers the possibility of an analogous process in the case of the Moon, and advances arguments to show that the origin and nature of major surface features on the Moon can be explained in terms of effects of the former presence of a lunar hydrosphere.

Gilvarry shows that such a lunar hydrosphere existed and lasted for a period at least of the order of 10^9 years, which is comparable with the duration (about $4{\cdot}5 \times 10^9$ years) of the Moon's lifetime. The maximum depth of the lunar hydrosphere has been estimated as about 2 km. This shows that sufficient water existed in the lunar hydrosphere to drown all the lowlands and to encroach significantly on the highlands, at one time.

If the Moon possessed an appreciable hydrosphere throughout a large fraction of its history, it follows that the level floors of the maria were formed by sediments deposited from the water in the course of its dissipation. Compaction of these should yield a softer rock than that forming the highlands, and this circumstance should be reflected systematically in the features characterising the different classes of lunar craters.

Gilvarry has made a detailed analysis of the different classes of lunar craters and shows that if Baldwin's curve relating crater depth to diameter (see *Curr. Sci.*, 1960, 29, 205) is extended to include the effect of crater formation in hard or soft rock, it is observed that of the lunar craters in Class I, 80 have been classified as Class I (*h*), occurring in the highlands, and 84 as Class I (*s*), occurring in the floors of the maria. This extension when applied to terrestrial craters also brings out their division into two classes, for hard and soft rocks respectively.

The presence of a lunar hydrosphere of the age calculated (10^9 years) yields a direct explanation of the various crater features observed, the origin of the maria, and the nature of the maria floor. Further it will be reasonable to suppose that the existence of an atmosphere and hydrosphere for an extended time would have provided all the requirements for biopœsis and one can speculate that life originated on the Moon through the process postulated by Oparin. The existence at one time of a primitive form of life in the lunar hydrosphere would also explain the dark colour of the maria as due to organic carbon left in the sediment. The inferred presence of organic carbon in the maria and adjacent craters would explain in a natural way the recent observations by Kozyrev, of the Swan bands of C_2 as the result of sublimation of carbon by the heat of a meteorite impact, and there is no need to invoke volcanic activity on the Moon.

A New Class of Conductive Organic Solids

A group of highly conductive organic solids has been discovered. These materials are salts of the radical-anion formed by addition of an electron to tetracyanoquinodimethan (TCNQ). In combination with a variety of cations, the $(TCNQ\cdot)^-$ radical-anion forms two series of salts having the compositions $M^+(TCNQ\cdot)^-$ and $M^+(TCNQ\cdot)^-(TCNQ)^0$, respectively. In both type of salts the band formed from the lowest normally unfilled molecular orbital of the TCNQ is partially filled, being half-filled for the first series of salts and one-quarter filled for the second. As a result of the relatively weak intermolecular interactions characteristic of molecular crystals this band will be quite narrow. In addition, both the bandwidth and the exchange coupling of the odd electron appear to be strongly influenced by the nature of the cation M^+, and by whether or not $(TCNQ\cdot)^0$ is present in the crystal. These features make the substances uniquely suitable for experimental study of electronic conduction and interaction in solids.—(*Phys. Rev. Letters*, 1960, 5, 503.)

Calculating the Age of Meteorites

Results of high-energy nuclear experiments conducted at the Joint Nuclear Research Institution in Dubna near Moscow, have enabled Russian scientists to confirm the hypothesis that isotopes of the gases neon and argon, constituting part of iron meteorites and differing from their counterparts on earth, are formed as a result of the disintegration of the iron nuclei by cosmic rays. This has been made possible by creating similar conditions for pure iron in the bombardment experiment in the laboratory, as meteorites are known to experience during their cosmic flight. For this purpose the iron was bombarded by protons on the synchrocyclotron of the Institute, with an energy resembling the conjectured energy of the cosmic rays, namely 660 Mev.

As a result of the bombardment all nuclei, knocked out of an iron meteorite in space under the impact of cosmic radiation, were obtained in laboratory conditions along with neon and argon isotopes. Among them were beryllium 10, cobalt 60, chlorine 36, and aluminium 28. These results indicate another possibility of

calculating the age of meteorites, and the time since they fell on earth. Moreover, these experiments determine the most probable energy of cosmic rays which meteorites encounter in outer space.—(*USSR News.*)

Nature of Tooth Enamel Protein as Shown by X-Ray Diffraction

Results of recent investigation by X-ray diffraction method seem to confirm that the tooth enamel protein has a keratinous and not a collagenous nature. Tooth enamel is the hardest tissue of the human body. It is far more densely calcified than bone, consisting of more than 96% of orientated hydroxy-apatite crystallites embedded in an organic matrix the weight of which, when dry, amounts to roughly 0·5%. The enamel being produced by cells of ectodermal origin it was generally believed that the organic matter must be of a keratinous nature, but investigations on the amino-acids of the enamel protein created some doubts, as its hydroxy-proline content suggested some affinity with collagen. Moreover, the sulphur-containing amino-acid cystine was present in much smaller amounts than in keratins.

It is clear that an intimate connection must exist between the apatite crystal structure and the repeat of molecular building units in the enamel protein. Only then is it plausible that a mass of very small apatite crystallites can be cemented together to such a rigid texture as tooth enamel shows.

Study of X-ray diffraction patterns of tooth enamel protein will enable the measurements of repeat distances and thus allow the nature of the protein to be established. W. G. Perdok has reported the results of preliminary X-ray diffraction study of tooth enamel protein (*Proc. Roy. Neder. Acad.*, 1960, 63, 627). A successful decalcification method was devised by which the organic matrix could be separated in a state and concentration suitable for X-ray diffraction patterns to be obtained. It was observed that the patterns were similar to the fibre patterns of wool and calf's tendon.

The pattern shows an equatorial arc of 13·5 A and an equatorial diffuse spot of 9·5 A, these spacings being close to respectively 3× and 2× the backbone spacing of the keratins 4·65 A. In collagen the corresponding spacings are 12 and 4·4 A. However, in the tooth enamel pattern the strong and characteristic equatorial reflection of β-keratin at 4·65 A is missing. The meridonial reflections show a sharp arc indicating a chain repeat of 19·9 A (6× characteristic fibre repeat of β-keratin 3·33 A), and a diffuse spot of 7·0 A. The fibre repeats of collagen are 8·9 and 2·87 A. These results support the histological evidence from enamel development studies that the tooth enamel is keratinous in nature. However, as the X-ray patterns lack some characteristic reflections of α-, as well as β-keratin the dental keratin may be called δ-keratin.

Ferrielectrics

Sodium vanadate and sodium niobate are known to be antiferroelectric. They do not exhibit ferroelectric behaviour at low field strength in their pure state. However, it has been found that the mixed crystal sodium vanadate-niobate, represented by the general composition $Na\ (V_xNb_{1-x})\ O_3$, exhibits ferroelectric behaviour. It shows an antiferroelectric Curie point at 375° C. and a ferroelectric behaviour below 225° C. These transition points vary slightly with the composition.

Mixed crystals produced up to a 50-50% composition are cubic and transparent with clear-cut shiny faces. They have easy cleavage planes and show large homogeneous domain areas. Results of ferroelectric behaviour show that coercivity as well as polarization of the crystals are dependent on composition. As the vanadate substitution increases coercivity decreases, and saturation polarization increases.

Like sodium niobate silver niobate is also known to be antiferroelectric. The composition $(Na_{1-x}Ag_x)\ NbO_3$ was also investigated and similar results were obtained exhibiting excellent hysteresis loops, and transients.

Using the three antiferroelectrics of the niobate group, a few batches of the multicomponent system described by the general formula $(Na_{1-x}Ag_x)_{1-y}(Nb_{1-x}V_x)_yO_3$ were also prepared. These compositions gave good crystals which showed ferroelectric properties similar to the above.

These studies show that the materials composed of two antiferroelectrics, the dipoles of which however are unequal, exhibit strong dipole-dipole interaction resulting in the onset of the ferroelectric state at a maximum applied field. This new group of materials with ferroelectric properties may be called "*ferrielectrics*" because of its analogy with *ferrimagnetic* materials.

It is assumed that other materials composed of sublattices with interlaced unbalanced antidipole structure representing an incompletely compensated antiferroelectric material may also exhibit ferrielectric behaviour.—(*Phys. Rev.*, 1960, 120, 1670.)

A New Light Amplifier Tube to Photograph Cosmic Ray Tracks

A new electronic tube, called the Astracon, enables one to photograph the faint tracks of cosmic rays as they move through a solid crystal at speeds near the velocity of light. Although cosmic rays or other high-energy particles remain within the crystal only about a billionth of a second, they leave luminous tracks which reveal their identity and behaviour. These tracks, however, are much too dim to be seen or photographed without some means of greatly increasing their brightness. This brightening is accomplished by the new light amplifier tube Astracon. The Astracon takes the incoming photons and uses them to release electrons from a light-sensitive input surface. The emitted electrons are accelerated and guided successively onto a series of thin films. At each film, an incident electron ejects five or six additional electrons, which move on to the next film. After being multiplied in this way through several stages, the electrons strike a phosphor screen similar to that in the viewing end of a television picture tube. Here they re-emit about 10,000 photons of light (in a four-stage tube) for each photon that originally entered the tube. As a result, dim "unseeable" images on the tube's input surface are increased in brightness at the output as much as several thousand times. The degree of light amplification which the Astracon provides should make the scintillation crystal an increasingly effective tool of modern physics, where it will supplement the more familiar cloud chamber and bubble chamber in nuclear and cosmic ray research.

The working of the Astracon light amplifier equipment may be described thus: The light that is generating along the path of a cosmic ray or other high-energy particle moving through the crystal is focused by a mirror system onto the input surface of an Astracon tube. The image produced by the tube then passes through a lens system which focuses it onto the input surface of a second Astracon tube. This second tube is triggered to operate only when a desired flash of light occurs in the crystal. Thus, it acts as a shutter that can be opened or closed in a small fraction of a second and also as an amplifier of light during the time it is turned on. The final image produced by the second Astracon tube is then directed onto a photographic film, which records the pictures of the path of the particle.

The Astracon already has been used experimentally in astronomy for increasing the brightness of the images and spectra of distant stars.—(*Westinghouse News.*)

Radioisotopes in Biology

The present trend in biology is towards the extensive use of physical and chemical methods of investigating the basic life processes.

The outstanding achievements of physics in electronics and the study of the molecular and atomic microcosm, and of chemistry, in investigation of the structure and properties of complex substances, especially the polymers which constitute the basis of life, are leading biology into a new period in its development, that of physical and chemical biology. Research workers are now concentrating primarily on the problems of finding the physical and chemical bases of vital phenomena, constructing a firm bridge between the living organism and inorganic matter, and penetrating the secrets of the growth, reproduction, heredity, mutation and so on—at the submicroscopic, molecular level.

The answers are being sought chiefly through modern physical and physical-chemical methods of investigation. One of the most important of these methods is the use of radioactive isotopes. Now it is possible to produce radioactive isotopes of nearly all the elements that make up living organisms. The radioactive isotopes H^3, C^{14}, Na^{24}, P^{32}, S^{35}, Cl^{36}, K^{42}, Ca^{45}, Mn^{54}, Fe^{59}, Co^{60}, Zn^{65}, Br^{82}, Rb^{86}, Sr^{90}, I^{128}, and I^{131} have become especially important in the study of life processes.

In the present survey the author has attempted to outline the main and most promising trends in the application of radioactive tracers to biochemistry, plant and animal physiology, microbiology and immunology, histomorphological research, hydrobiology, entomology, ichthyology, genetics and other biological disciplines, giving a complete picture of the use of isotopes in biology.

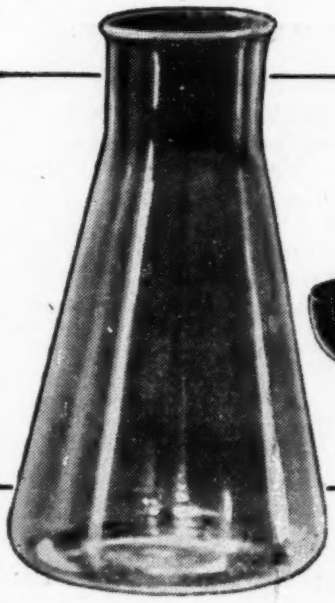
* Review Series No. 7, *The Application of Radioisotopes in Biology*, by A. M. Kuzin, USSR, in Russian and English, International Atomic Energy Agency, Price $ 1·00; 6 *sh.*

49-61. Printed at The Bangalore Press, Bangalore City, by T. K. Balakrishnan, Superintendent, and Published by A. V. Telang, M.A., for the Current Science Association, Bangalore.

All material intended for publication and books for review should be addressed to the Editor, *Current Science*, Raman Research Institute, Bangalore-6.

Business correspondence, remittances, subscriptions, advertisements, exchange journals. etc., should be addressed to the Manager, Current Science Association, Bangalore-6.

Subscription Rates: India: Rs. 12-00. Foreign: Rs. 16-00; £ 1-4-0; $ 4.00.



B.K.S. SKYREX

BKS

SKYREX

High Silica low expansion heat proof resistant glassware of best class for laboratory and industry

Manufactured by

B.K. SHAW Industries (Private) Ltd.

P-3, B. K. PAUL AVENUE, CALCUTTA-5

BKSI-5

We design and supply :

VARIOUS TYPES OF

ELECTRONIC EQUIPMENT

SUCH AS

STABILIZED POWER SUPPLY UNITS

BATTERY CHARGERS FOR HOME, GARAGE AND GENERAL PURPOSE
NEON SIGN TRANSFORMERS

CONSTANT VOLTAGE, BOOSTING, GLOW DISCHARGE, STEP-UP, STEP-DOWN TRANSFORMERS

BATTERY ELIMINATORS, METAL RECTIFIERS, WAVE-BAND SWITCHES, ETC., ETC.

FOR ANY DESIRED SPECIFICATIONS

We have been designing and supplying to the market various Electrical and Electronic Equipment for over 15 years past

GUARANTEED SERVICE PROMPT ATTENTION

RADIO ELECTRIC (PRIVATE) LTD.

2 B, LAMINGTON CHAMBERS, LAMINGTON ROAD

BOMBAY 4

SP./RE./3

For

ZOOLOGICAL SPECIMENS
REQUIRED BY
LABORATORIES
AND
INSTITUTIONS

Consult:

Bombay Biological House

Dealers in Zoological Specimens

119, Hindu Colony, Dadar, Bombay 14

Established 1941

Phone : 61813 Gram : PHERETIMA

KINDLY CONTACT US:

- Physics Instruments.
- Laboratory Glassware and Thermometers.
- Laboratory Porcelainware and Silicaware.
- Balances, Analytical, Physical and Chemical.
- Student's Microscopes and all other requirements for Biology Department.
- Ovens, Incubators, Centrifuges, Etc.
- Laboratory Chemicals.
- Movie Projectors, Slide/Filmstrip Projectors, Epidiascopes, Public Address System, Tape Recorders and Cameras for Research Work.

M/s. INDSALES Corporation

11, HORNIMAN CIRCLE
BOMBAY-1

Phone : 253264 Grams : 'ANALYTICAL'

BOROSIL

LABORATORY GLASSWARE

such as

FLASKS, BEAKERS, CONDENSERS, MEASURING FLASKS, MEASURING CYLINDERS, PIPETTES & ANY SPECIAL APPARATUS MADE TO DESIGN

and

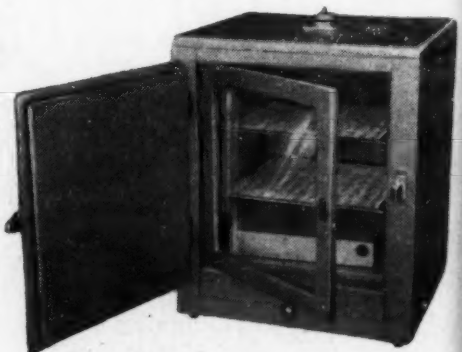
PENICILLIN VIALS, VACCINE BULBS— WHITE & AMBER

ALL OTHER APPARATUS & EQUIPMENT MANUFACTURED TO CLIENT'S DESIGN

INDUSTRIAL & ENGINEERING APPARATUS CO. (PRIVATE) LTD.

CHOTANI ESTATES, PROCTOR ROAD
GRANT ROAD, BOMBAY 7

TEMPO LABORATORY EQUIPMENT



(INCUBATOR Bacteriological)

TEMPO INDUSTRIAL CORPORATION (PRIVATE) LTD.

Sonary Road, Paranjpe 'B' Scheme, BOMBAY-57

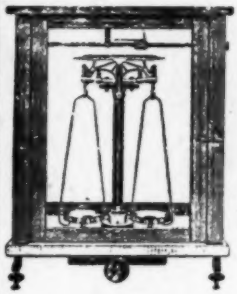
SPECTROSCOPIC EQUIPMENT
AND
ACCESSORIES
FOR
QUANTITATIVE ANALYSIS & RESEARCH WORK

Light sources like Arc Lamps with universal movements, precision slits, mountings for spectrographs, cameras, microphotometers, etc., etc.

Entirely Our Manufacture

For full particulars, please write to :

THE GENERAL ENGINEERING AND SCIENTIFIC CO.
WALTAIR, VISAKHAPATNAM-3
(S. INDIA)
GRAMS : " ELECTRONIC "
Technical Adviser:
Dr. I. RAMAKRISHNA RAO
M.A., Ph.D. (Cal.), D.Sc. (Lond.)



KEROY
Short Beam Analytical Balance
No. K 1

Really Dependable Balance for Degree Classes and Research Laboratories

Sensitiveness .. 1/10th mg.
Capacity .. .. 200 gm.

Catalogue on Request

Manufactured by :

Keroy (Private) Ltd.
BANARAS CANTT. :: CALCUTTA 10
"Calcutta Telephone No. is 24-3840"

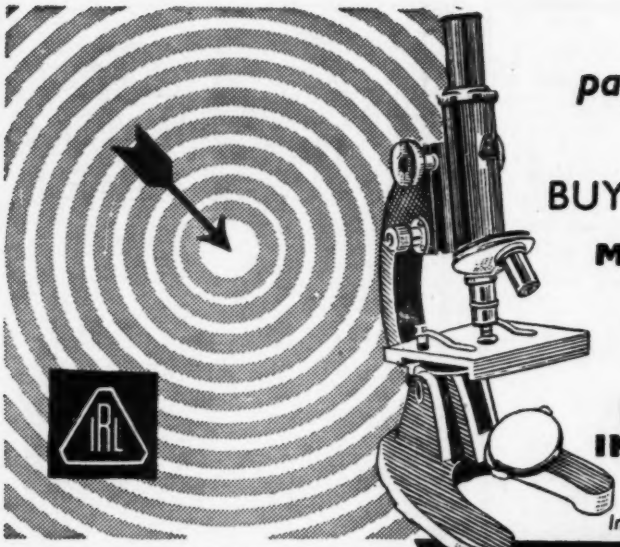
INSIST ON " QUICO " PRODUCTS

"QUICO" STUDENTS MICROSCOPE

Stand of generous proportions inclinable by 90° with a fixed tube, without a condenser, with disc. diaphragm below the stage. Optical equipment: Nosepiece for 3 objectives; Originally imported German; 2 Achromatic objectives 10*x* & 45*x*; 2 Huygens eyepieces 10*x* and 15*x*; 4 different magnifications from 100 to 675*x* in a fine-wood cabinet with lock and key

Please Contact
Sole Selling Agents :
UNIQUE TRADING CORPORATION
221, Sheriff Devji Street
BOMBAY-3

PHONE : 30011 GRAMS : "UNILAB"



pay for precision

BUY IRL PRODUCTS

MICROSCOPES
and
PRECISION OPTICAL MEASURING INSTRUMENTS

India's Leading Manufacturers

INSTRUMENT RESEARCH LABORATORY LTD. CALCUTTA.

Sole Selling Agents
MERCANTILE UNION PRIVATE LTD.
309, Bepin Behary Ganguly Street, Calcutta 12
Phone : 22-5778

NA IRL-3-()

VERY RELIABLE INDIGENOUS SUBSTITUTES OF GUARANTEED ANALYTICAL REAGENTS MAY BE FOUND IN

"BASYNTH"
Brand
ANALYTICAL REAGENT

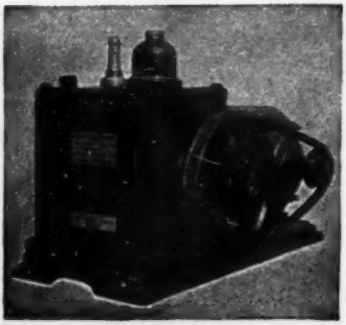
Acid Hydrochloric
Acid Hydrochloric Fuming
Acid Sulphuric
Acid Nitric
Acid Nitric Fuming
Acid Acetic Glacial
Ammonium Hydroxide
Benzene
Toluene
Xylene
Petroleum Ether
Amyl Alcohol
Butyl Alcohol Etc., Etc.

Basic & Synthetic Chemicals (Private) Ltd.
P. O. Jadavpur University, Calcutta-32

MADE IN INDIA

HIGH VACUUM
ROTARY PUMP
SINGLE STAGE & TWO STAGE
with or without Air Ballast

All Indian materials and construction



BASIC & SYNTHETIC CHEMICALS (PRIVATE) LTD.
P.O. Jadavpur University, CALCUTTA 32

fair chance for young talent

Some 48,000 children are at school in Jamshedpur, where Tata Steel runs 34 schools—17 of them on two shifts—and assists 122 other schools with recurring or capital grants. Instruction up to matriculation is given in four languages to meet the needs of the cosmopolitan industrial community.

Employees' children are taught free or pay a concessional fee depending on the parents' income. Here, we see Shri Etwari of Monghyr, an operative in the steel works, and his son, Kameshwar Prasad. Kameshwar passed matriculation in the first division in 1959, qualifying for a university stipend and for a Tata Steel Jubilee scholarship of Rs. 75 per month which will see him through college without any strain on his father's modest resources.

Jubilee scholarships apart, Tata Steel provides assistance in several ways to enable deserving children to take up higher studies. Young talent is thus encouraged and nurtured at Jamshedpur, where industry is not merely a source of livelihood but a way of life.

JAMSHEDPUR

THE STEEL CITY

The Tata Iron and Steel Company Limited

TTN 4501

Sigcol

LABORATORY
GLASS APPARATUS

Sole Selling Agents:

GHARPURE & CO.
P-36, ROYAL EXCHANGE PLACE EXTN.
CALCUTTA 1
Gram: "MEENAMO" Phone: 22-2061

'STANDARD' RHEOSTATS

SINGLE, DOUBLE & FOUR-TUBE

COVER A WIDE RANGE
FOR USE IN
LABORATORIES & WORKSHOPS

Made by:

THE STANDARD SCIENTIFIC
INSTRUMENTS CO.
115, BRODIES ROAD, MADRAS 28

ZOOLOGICAL SOCIETY OF INDIA
(Estd. 1939)
(Registered under Societies Registration Act 21 of 1861)

Membership Subscription: Rs. 15/- per year with Journal; Rs. 10/- without Journal; Admission Fee Rs. 10/-

Publications:

The Journal of the Zoological Society of India

Started 1949; Published bi-annually; Annual Subscription Inland Rs. 20/-; Foreign Rs. 22/-

A few back numbers are available, subject to prior sale
Selected Advertisement accepted

Bulletin: Numbers 1 & 2

Year-Book: Started since 1956-57

Indian Zoological Memoirs on Indian Animal Types (initiated by late Prof. K. N. Bahl)

Nos. 3 (Ostrea), 6 (Palaemon) and 7 (Salmacis)

Other publications available: Reprints of a few papers of the Indian Helminthologist, the late Dr. G. D. Bhalerao. **Indian Journal of Helminthology** (started since 1949); and Prof. Thapar's 60th Birthday Commemoration volume.

All orders, remittances and communications regarding above should be addressed to the **Honorary Treasurer, Zoological Society of India, 34, Chittaranjan Avenue, Calcutta 12.**

PHOTOSTAT SERVICE

Indian Institute of Science Library can supply PHOTOCOPIES of Articles, Graphs, Charts, Illustrations, Blue Prints, etc., from the Scientific and Technical Publications available in the Library, to Scientists and Scientific Institutions.

Enlarged or Reduced Copies can also be supplied wherever possible

Size upto	Rates per page, per copy
11"×6"	Re. 0·50
17"×11"	Re. 0·75
23"×17"	Rs. 1·25

(Packing and postage extra)

For further particulars contact:

LIBRARIAN
INDIAN INSTITUTE OF SCIENCE
BANGALORE 12, INDIA

For the attention of Post-Graduate Teaching and Research Laboratories

IF YOUR INTEREST LIES IN	YOU MUST HAVE
Botany **Zoology**	Bausch & Lomb 'STEREO-ZOOM' Stereomicroscopes
Chemistry	Bausch & Lomb 'SPECTRONIC 505' Automatic Recording Spectrophotometer
	Gallenkamp ADIABATIC Bomb Calorimeter
	Stanton UNIMATIC Single Pan Balance
Medical Sciences	Bausch & Lomb 'SPECTRONIC 20' Colorimeter—Spectrophotometer
Physics	Bausch & Lomb CERTIFIED-PRECISION Diffraction Gratings (Replicas)
Geology	Ward's SYSTEMATIC Museum Collections
Research	Gallenkamp HUMIDITY OVEN
	Stanton Automatic THERMORECORDING Balance

Please write to us for descriptive Catalogues as required

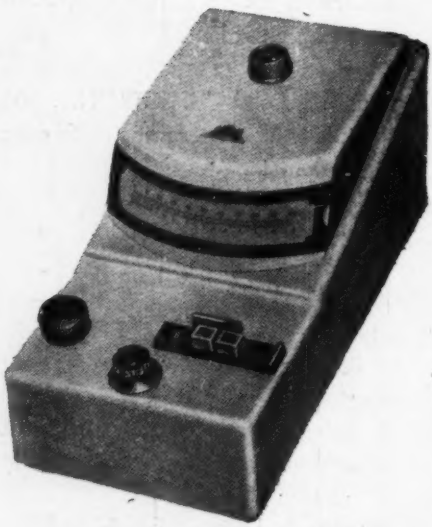
MARTIN & HARRIS (PRIVATE) LTD.

(SCIENTIFIC DIVISION)

SAVOY CHAMBERS, WALLACE STREET, BOMBAY 1

UNICAM SP-300

G.P. PHOTO ELECTRIC COLORIMETER



The Unicam G.P. Colorimeter is a self-contained unit designed to work either from a 6-volt battery or direct from a 220–250-volt A.C. mains supply through a constant voltage transformer built into the instrument. Suitable plugs and sockets are fitted at the back of the case. A separate container is provided for the accommodation of accessories.

An important feature of this colorimeter is the dual cell holder which brings either cell into the same position relative to the light path. The light is controlled by a three-position switch marked "Battery", "Mains" and "Off", and by a shutter mechanism operated by the control marked "Increase Light".

The light passes through an absorption cell with an optical path of 10 mm., which holds the solution under test. Through the selected filter the transmitted light reaches the barrier layer photocell, the out-put current of which is indicated on the galvanometer.

The galvanometer is calibrated with a linear scale 0-100 underneath which is a logarithmic scale for calculations of optical density. The scale is easily removable and others can be fitted to suit any special requirements. Reproducibility is constant.

Measurement procedure is both simple and rapid and is particulary suited to the comparison with a standard of samples in larger numbers.

FOR FURTHER PARTICULARS PLEASE WRITE TO:

Sole Distributors

THE SCIENTIFIC INSTRUMENT COMPANY LTD.

ALLAHABAD BOMBAY CALCUTTA MADRAS NEW DELHI